B&G
EXCELLENCE IN MARINE ELECTRONICS
A Simrad Company

CAUTION!
Use of solvent based or chemical cleaners on the displays will result in damage and invalidate the warranty

h1000 pilot installation manual

HB-1000I-02 English

WARNING!

An autopilot is a very useful navigational aid, but DOES NOT under any circumstance replace a human navigator.

Do not use automatic steering when:

- In heavy traffic areas or in narrow waters
- In poor visibility or extreme sea conditions
- When in areas where use of an autopilot is prohibited by law

When using an autopilot:

- Do not leave the helm unattended
- Do not place any magnetic material or equipment near magnetic or fluxgate compass used in the autopilot system
- Verify at regular intervals course and position of vessel
- Always switch OFF the autopilot in due time to avoid hazardous situations

contents

contents 1

h1000 pilot display 4
- description 4
- siting the pilot head 4
- mounting procedure 5
- panel mounting 5

h1000 compass unit 6
- description 6
- siting the compass unit 6
- mounting procedure 6

rudder reference unit (rru) 7
- description 7
- key points when installing the rru 7

linear feedback unit 11

rudder drive options 12
- ram drive unit 12
- description 12
- hydraulic linear drives 12

hydraulic ram drive dimensions (T0-12V) 14

hydraulic ram drive dimensions (T1-12V, T2-12V, T2-24V) 15

size 3 hydraulic ram drive dimensions, 24V 17

ram drive unit installation 19
- key points on installation 19

layout of typical ram drive unit 20

ram mounted parallel to vessel's centre-line 21
- key points on installation 22
- mounting a hydraulic linear ram on a vertical bulkhead 22
- vertical bulkhead installation 23
- splitting the ram drive unit 24
- type 1 and type 2 units 24
- type 3 units 24

hydraulic drive pumps 25
- description 25
- pump data 25
- key points on installation 25

hydraulic drive pump dimensions 26
- type 1 and 2 26
- type 3 26

hydraulic drive pump installation 27

contents

hydraulic drive pump installation examples **28**
- single station system example 28
- dual station system example 28
- dual station system with bypass example 29
- dual station pressurised system example 29

advanced control processor unit (acp) **30**
- description 30
- siting the acp 30
- mounting procedure 30
- cable and connection information 31
- emc compliance 31
- general wiring notes 31
- all rudder drives – heavy duty power cables 32
- linear drives – clutch/valve cables 32
- acp unit terminal details 32
- wire colour coding and abbreviations 32

wiring connections **33**
- clutch voltage selection 33
- acp dip switch location 34
- h1000 and alarm connections 35
- hand-held, mob and joystick 36
- hydraulic ram drive connections 37
- ram solenoid wiring details 38
- hydraulic pump connections 39
- continuous drive connections 40
- direct paddle input connection 41
- linear feedback connection 42
- non-b&g paddle connection 43
- furuno ad10 heading connection 44

optional accessories **46**

hand-held controller **46**
- description 46
- siting the hand-held unit 46
- mounting procedure 46

man overboard button (mob) **47**
- description 47
- siting the man overboard alarm button 47
- mounting procedure 47

acp joystick **48**
- description 48
- siting the joystick 48
- mounting procedure 48

contents

h1000 pilot calibration **49**
- pilot installation checklist 49
- drive unit and steering system 49
- linear hydraulic rams 49
- size 3 ram installation checklist 49
- hydraulic pumps 49
- rotary drives 49
- rudder reference unit installation 50
- linear feedback unit installation 50
- compass installation 50
- electronics installation 50

speed calibration **51**

calibrating the pilot **53**

pilot calibration parameters **53**
- dockside calibration 53
- selecting the boat type 54
- setting the rudder end stops 54
- setting the port rudder stop 54
- setting the starboard rudder stop 54
- selecting the rudder drive type 54
- hardovertime 55
- waterline length 55
- magnetic dip angle 56
- magnetic dip angle compensation chart 56
- joystick control 56
- seatrial calibration 57
- compass calibration 58
- engaging the h1000 pilot 61
- setting the rudder midships position 61
- boat lag 61
- setting the boat lag value 62
- boat lag value table 62
- automatic rudder gain 62
- checking the automatic rudder gain learning 62
- manual rudder gain 63
- rudder gain value table 63

trouble shooting **61**
- uncalibrated 61
- no rudder position 61
- no drive selected 62
- no boat speed 62
- no heading data 62
- no nmea information 63
- nmea data unstable 63
- poor wind data 63
- current trip limit 63
- no pilot detected 63
- pilot not steering a straight course 64

h1000 pilot display

description

The h1000 pilot display is designed to be mounted above or below decks. The display head allows control of the pilot and by installing multiple display heads, gives control at any station. It can be connected to all other h1000 Instruments via the Fastnet^2 connectors to provide an integrated autopilot and navigational system.

Caution: it is essential that the pilot is calibrated before operation. Details are given in the calibration section of this manual.

In an integrated system, boat speed is supplied from the h1000 Speed/Depth Interface and wind speed and wind angle from the h1000 Wind Interface via Fastnet^2. These allow the pilot to operate in the Compass and Wind modes. When a CND or NMEA position fixer is connected to the system, Navigate mode becomes available. NMEA data is connected to the Universal Interface and then broadcast across Fastnet^2 and used by the pilot.

The display heads are supplied with a clip-in mounting bracket, which allows for easy installation. Access from behind is not necessary to secure the unit in place. However to prevent theft or if removal of the unit is not required, then locking studs and thumbnuts are supplied to allow for permanent fixing.

siting the pilot display head

h1000 instruments are designed for mounting above or below decks. Select a display site that is:

- At a convenient position within easy reach and view of the helmsman.
- On a smooth and flat surface.
- At a safe distance of 100mm (4") from any compasses.
- Protected from physical damage.
- Accessible from behind for fitting locking studs if required.

mounting procedure

panel mounting

Ensure that the display is installed on a flat surface, and there is sufficient room behind the panel to accommodate the fixings and connections. Using the template supplied, cut a hole in the panel in the desired position.

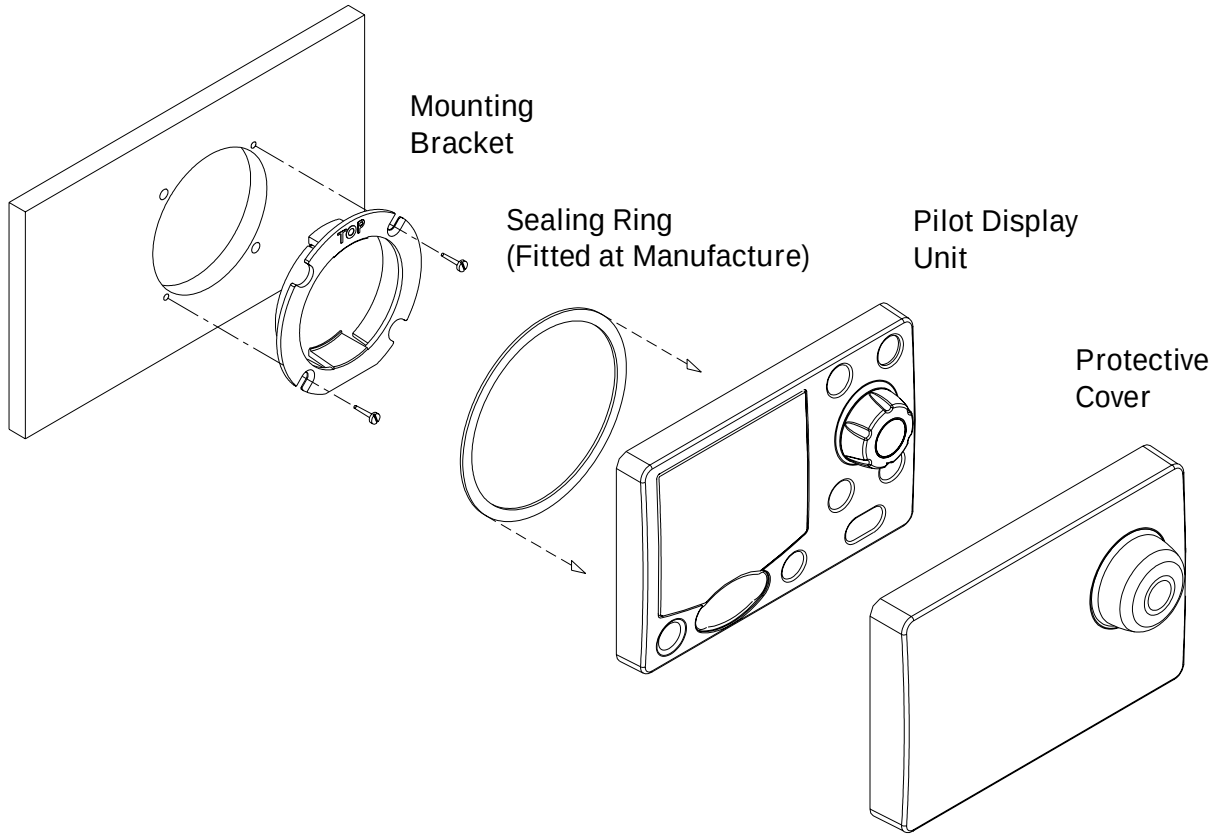
Fix the mounting bracket into the hole using the screws supplied.

Note: the sealing ring is fitted to the unit during manufacture, its purpose is to prevent moisture penetration and reduce the effects of any vibration transmitted through the instrument panel.

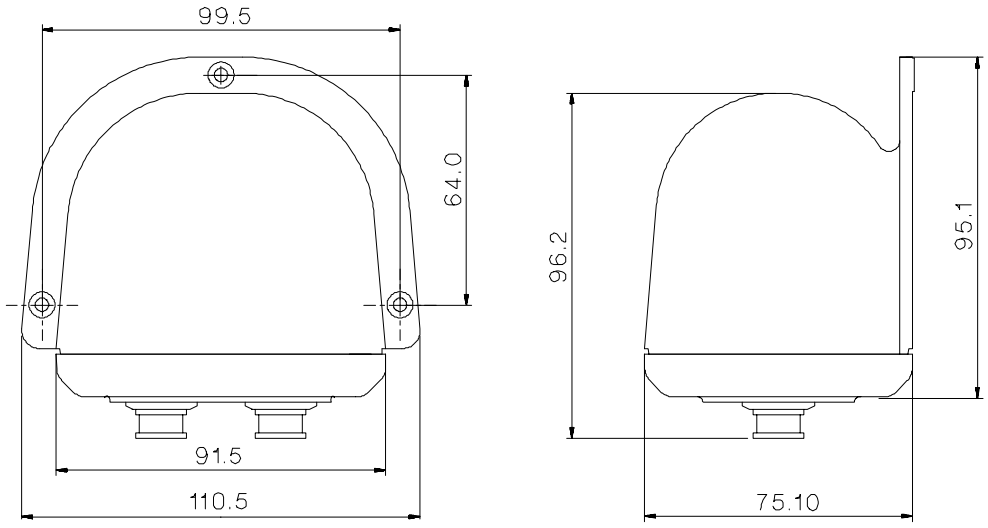
Press the **Pilot Display** firmly into the mounting bracket; an audible 'click' will indicate that the case is correctly located.

Secure the unit to the instrument panel by fitting the studs and thumbnuts supplied.

Caution: To avoid damaging the casing, fixing studs must only be tightened 'finger-tight'.



h1000 compass unit



description

The h1000 compass is an electronic fluxgate for use with all h1000 systems. The unit is housed in a sealed casing constructed of high impact plastic. It is therefore suitable for on or below deck mounting.

If installed in a vessel with a steel or reinforced concrete hull it may be necessary to install the compass unit outside the magnetic screening affect of the hull and super-structure.

Two Fastnet² connectors are provided at the base of the unit. These connectors allow connection to the rest of the system for the supply of power and data.

siting the compass unit

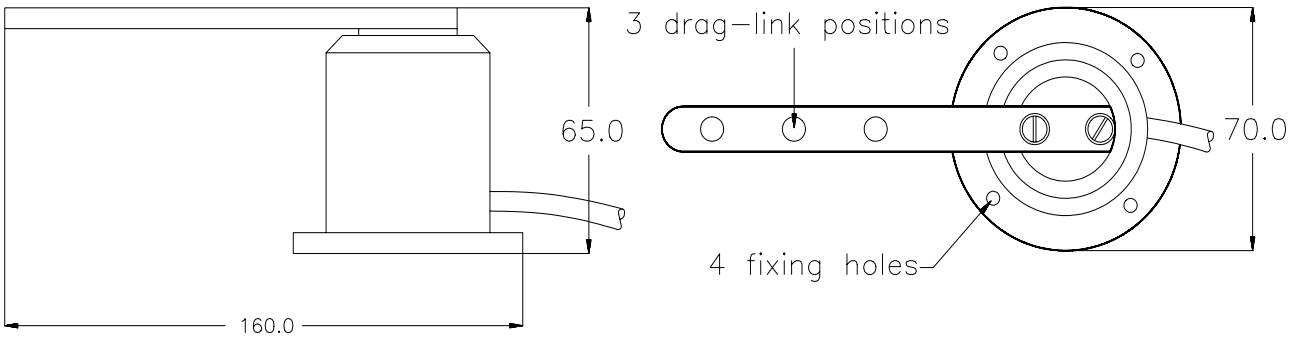
Mount the compass upright on a flat vertical bulkhead where it will be:

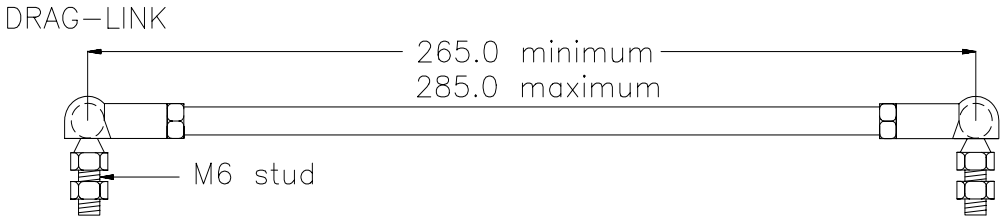
- A safe distance from external magnetic interference:
  3m (10ft) from VHF, RDF, loudspeakers, depth sounders, engines, or power cables carrying heavy current.
- 3m (10ft) from radar and SSB equipment.
- Externally mounted on steel vessels.
- Protected from physical damage.
- Protected from water ingress (particularly bilge water).
- Optimum positioning: as low as possible to minimise effect of pitching and rolling of boat.

mounting procedure

- Secure the unit in the selected site using the non-magnetic self-tapping screws provided.
- Route the Fastnet² cable to the rest of the system avoiding other cables carrying heavy currents, e.g. engine starter, trim-tabs, etc.
- Secure cables in place with cable clips or tie-wraps.
- Avoid bending the cable through a tight radius, especially near the connector as this may damage the wires inside the cable.

rudder reference unit (rru)





description

The Rudder Reference Unit (**rru**) is a sealed, high specification potentiometer in a robust casing, providing rudder position information to the pilot computer unit. The operating arm is constructed from aluminium with three positions pre-drilled for the adjustable drag-link. The drag-link has ball-joints at each end which connect the unit operating arm to the tiller arm or steering quadrant. The unit base has four holes to allow for mounting. The unit is supplied with 10m (30ft) of 3-core screened cable.

key points when installing the rru

- General consideration must be given to the steering system and its geometry before starting the RRU installation. Many factors must be contemplated for a practical solution. The information given here is for guidance only, although where a maximum or a minimum value is given these must be adhered to.

- Mount the rru on a flat surface next to the tiller arm or steering quadrant; construct a small platform if necessary.

- Do not lengthen the drag-link arm as this can transmit excessive vibration loads to the rru and will invalidate the warranty.

- The unit operating arm can be rotated through 360°; the mid-point of the potentiometer travel is when the operating arm is opposite the cable entry point.

- When the rudder is moved from hardover port to hardover starboard the rru arm should swing through a minimum of 90°. This will ensure that there is sufficient voltage swing to the autopilot.

rudder reference unit

Measure the voltage difference between the green and blue wires of the rru; there should be a minimum of 1V d.c. change from hardover to hardover.

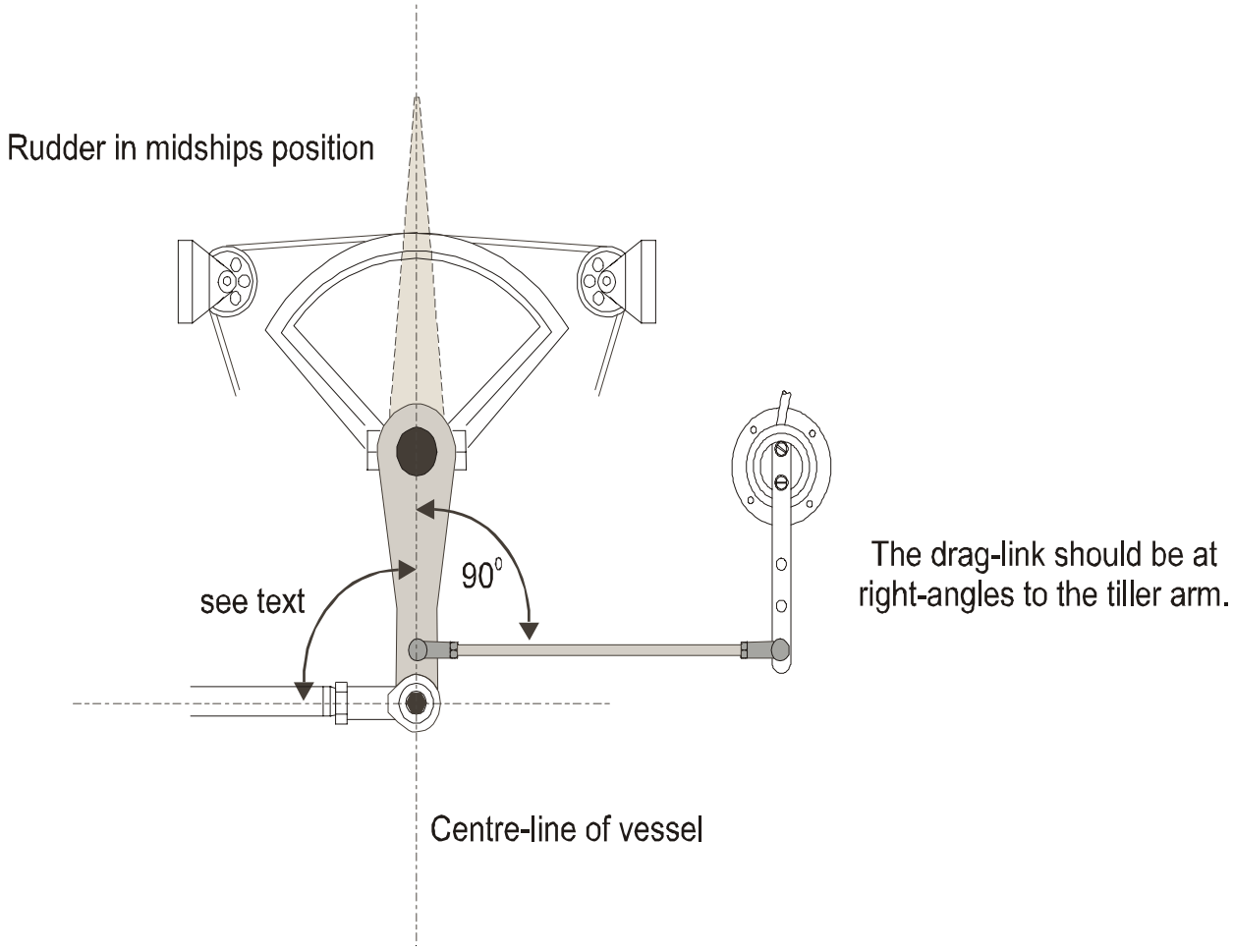
Note: If there is less than a 1V d.c. change the pilot will not commission.

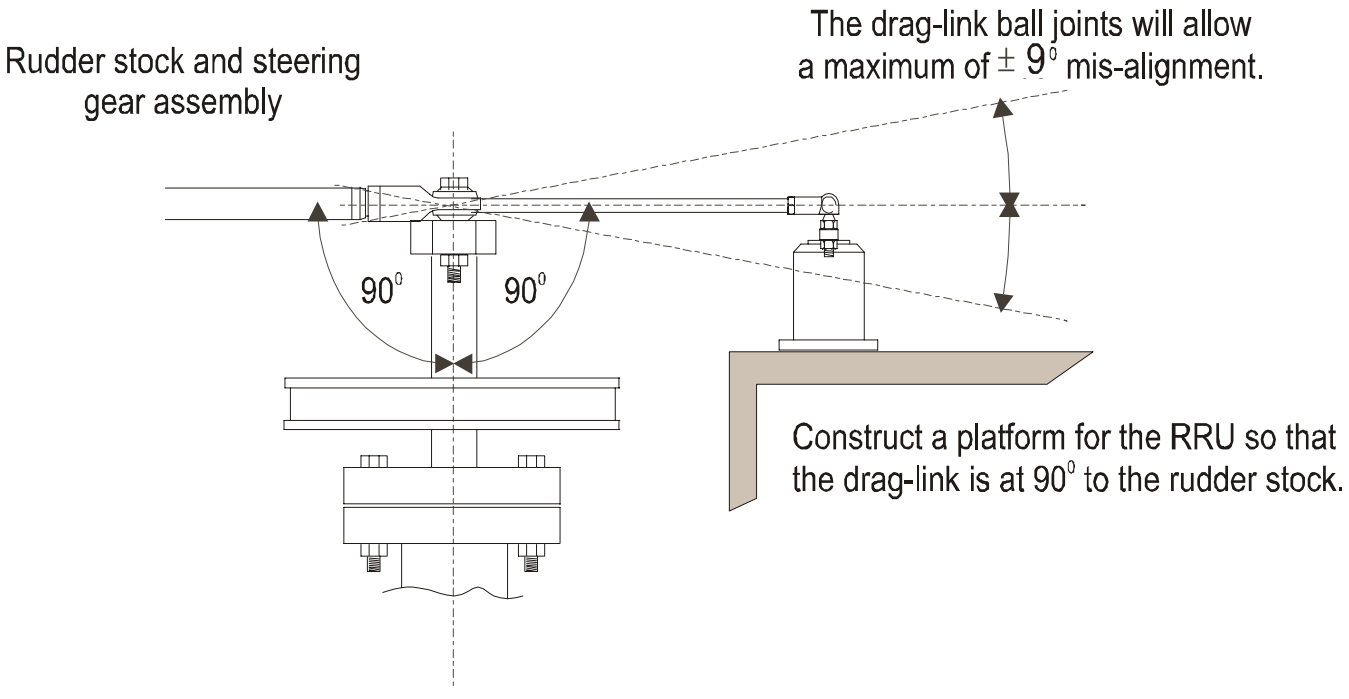
- After installation check full movement of the steering system ensuring that there is no fouling between the steering gear, rru parts and drive unit.

- Ensure that there is no backlash in the linkage between the rru and the steering gear, otherwise incorrect operation of the autopilot will occur.

The example shown overleaf is a plan view of a typical system with a tiller arm and quadrant. When viewed in elevation, the ram drive arm and rudder reference unit drag-link must not be more than ±9° from horizontal. Ideally, all components should be horizontally aligned as this prevents excessive stress during operation.

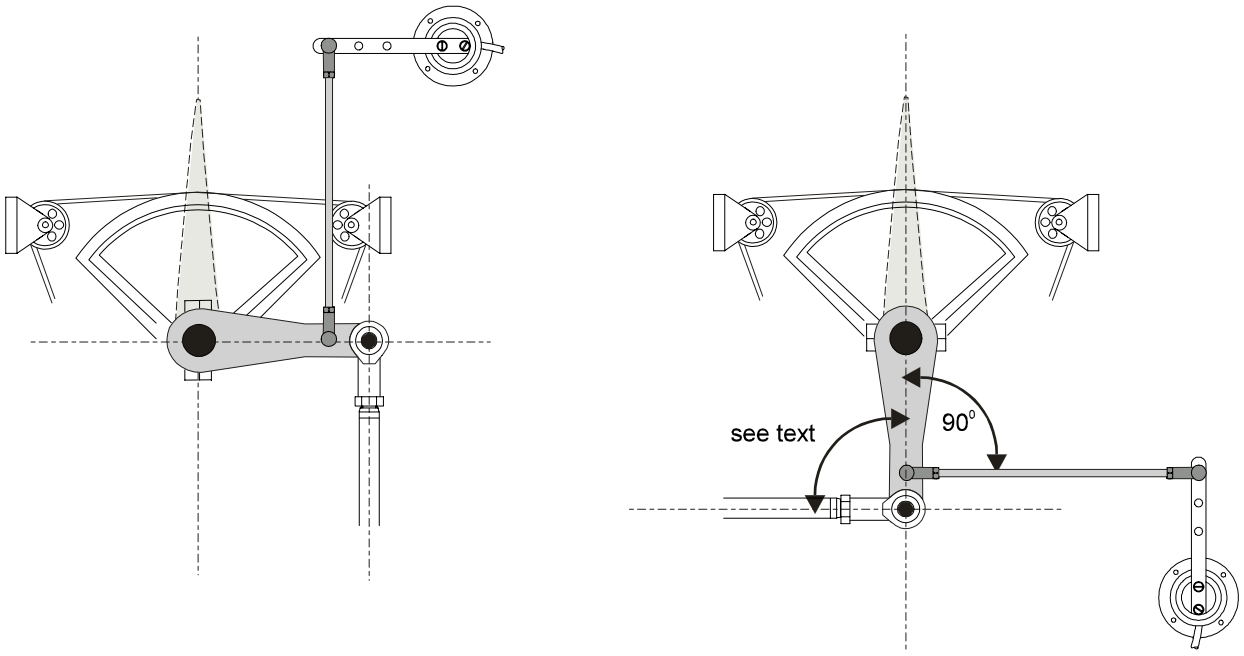
rudder reference unit



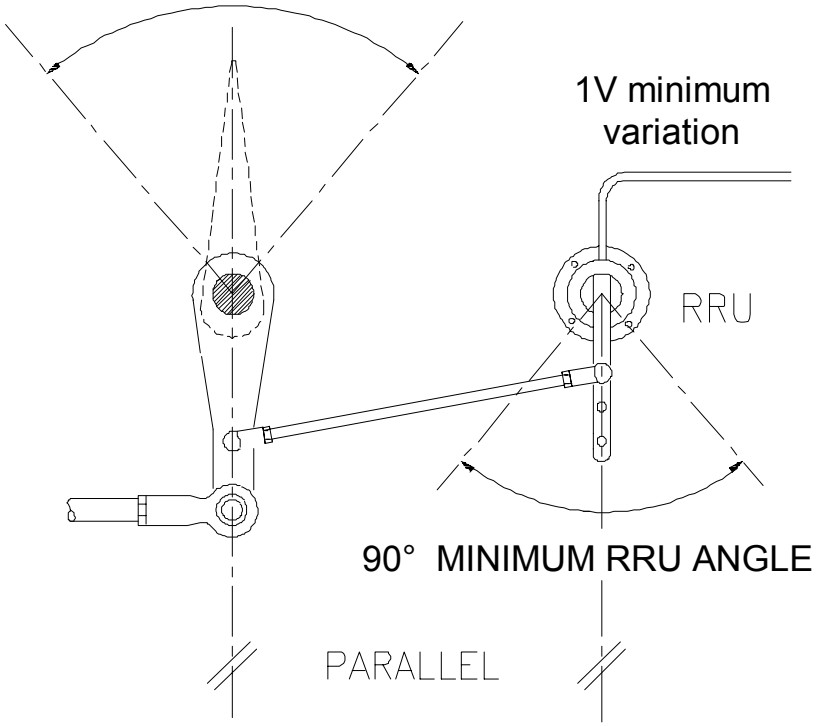

Rudder stock and steering gear assembly
The drag-link ball joints will allow a maximum of ± 9° mis-alignment.
90°
90°
Construct a platform for the RRU so that the drag-link is at 90° to the rudder stock.

rudder reference unit

The RRU can be mounted in a variety of positions and orientations depending on the layout of the steering system.

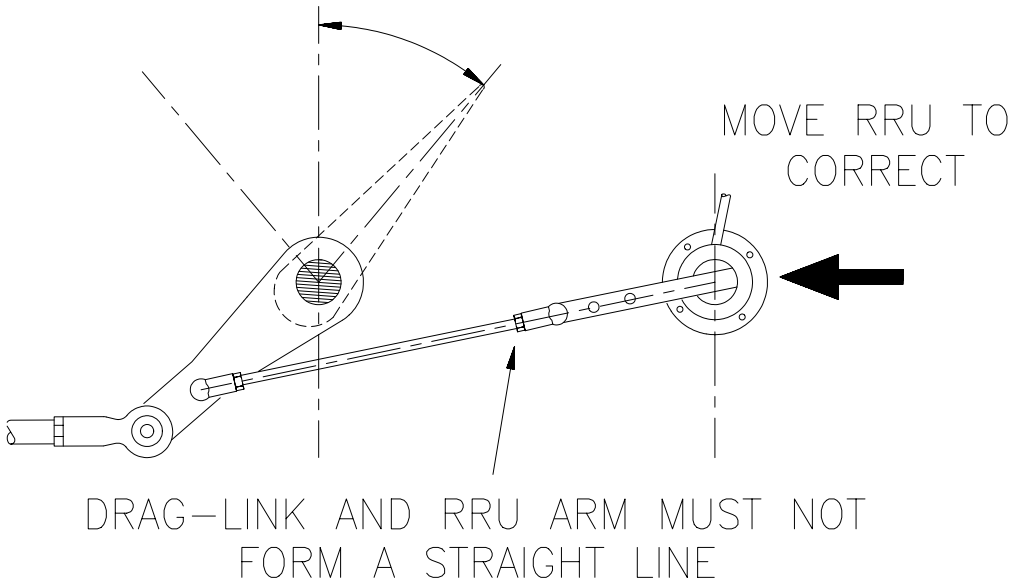


If the maximum rudder angle is less than 90° then the position of the RRU or the drag-link must be adjusted so that the operating arm of the RRU swings through a minimum of 90.



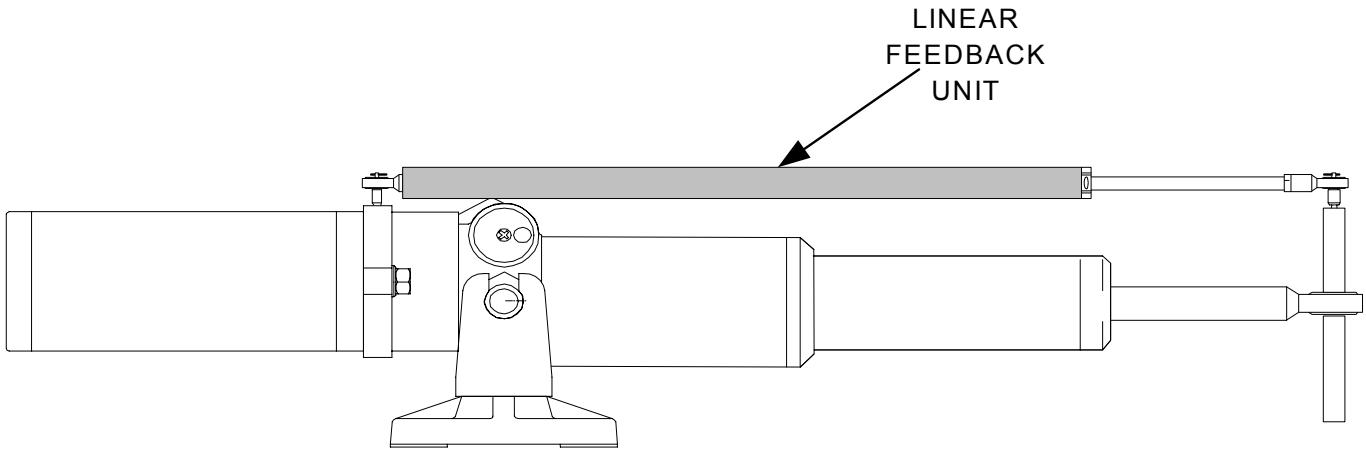
rudder reference unit

The rudder hardover angle should only be limited by the rudder stops, not the rru linkage or pilot drive unit. Check that when hardover, the rru arm and drag-link do not form a straight line. If this occurs the steering system could become damaged or jammed endangering the boat and crew. This fault can easily be rectified, by adjusting the position of the RRU.



linear feedback unit

Where installation of the conventional rudder reference unit is difficult or physically impossible, a linear feedback unit (SEN-RUD-LFB) can be used. The linear feedback unit comprises of a tube approximately 23mm (7/8 inch) in diameter and 300mm (12 inch) long. This assembly is attached to the top of the B&G Blue Ram Types T1 or T2. Each end of the linear feedback unit has a small rose-joint which is attached to corresponding pillars on the ram, the rose-joints are retained using washers and spring clips.



rudder drive options

warning

Accurate performance of the yacht's steering system is crucial to the safety of you and your crew. B&G always recommend that an Authorised B&G Dealer performs the installation of autopilot drive units.

caution

In line with B&G's policy of continuous product improvement, drive units are regularly updated. Installation data included with your drive unit will replace installation data contained in this manual. Before undertaking any shipwright work onboard the yacht, it is essential that the installation data in this manual be verified against your drive unit. If in doubt, consult your authorised B&G Dealer for technical assistance. B&G cannot accept liability for differences that may occur between the drive unit and this User Manual.

ram drive unit

description

A hydraulic pump driven from the dc electric supply combines a compact reversible pump and a hydraulic cylinder assembly for use on boats without hydraulic steering systems. Three sizes of ram drive units are available giving a wide range of thrust to suit all vessel types and sizes.

hydraulic linear drives

The Type 1 and Type 2 rams combine motor, pump and hydraulic cylinder as one unit, referred to as an actuator. Type 3 rams are supplied split into a separate motor/pump unit, reservoir and hydraulic cylinder, connected by 1m (3ft) hoses. The Type 3 motor/pump unit can be mounted on a vertical bulkhead.

Note: Longer hoses for the Type 3 system are available, please contact your dealer.

Ram Drive Type	RAM-T0-12V	RAM-T1-12V	RAM-T2-12V RAM-T2-24V	RAM-T3-24V
Motor Supply	12V dc	12V dc	12 or 24V dc	24V dc
Solenoid Valve Supply	12V dc 1.25A (max)	12V dc 1.25A (max)	12 or 24V dc 1.25A (max)	24V dc 0.8A (max)
Peak Thrust	300 kg force (660 lbs force)	680 kg force (1496 lbs force)	680 kg force (1496 lbs force)	1062 kg force (2342 lbs force)
Peak Current	20A @ 12V	20A @ 12V	25A @ 12 or 24V	17A @ 24V
Maximum Stroke	203mm (8")	254mm (10")	254mm (10")	305mm (12")
Rod Diameter	12mm (0.472")	16mm (0.623")	16mm (0.623")	20mm (0.623")
Tiller Arm for 70° Rudder	178mm (7")	214mm (8.4")	214mm (8.4")	257mm (10.16")
Maximum Torque	545 Nm (4823.65 lb.ins)	1427 Nm (12574 lb.ins)	1427 Nm (12566 lb.ins)	2688 Nm (23780 lb.ins)
Weight	5.8 kg (12.7 lbs 6oz)	7 kg (15 lbs 6oz)	7 kg (15 lbs 6oz)	10.3 kg (22lbs 11oz)
Helm to Helm Time *Extend* *Retract*	 10.1sec 9.9 sec (200kg force)	 15.7 sec 13.4 sec (200kg force)	 11.9 sec 10.2 sec (200kg force)	 14.6 sec 12.6 sec (200kg force)

rudder drive options

The following tables indicate the tiller arm length required for the different types of drives.

RAM T0 Hydraulic Linear Drive

RAM–T0–12V	Midstroke 429mm (16.9”)
½ Max. Rudder Angle	Tiller Arm
35°	178mm (7.0”)

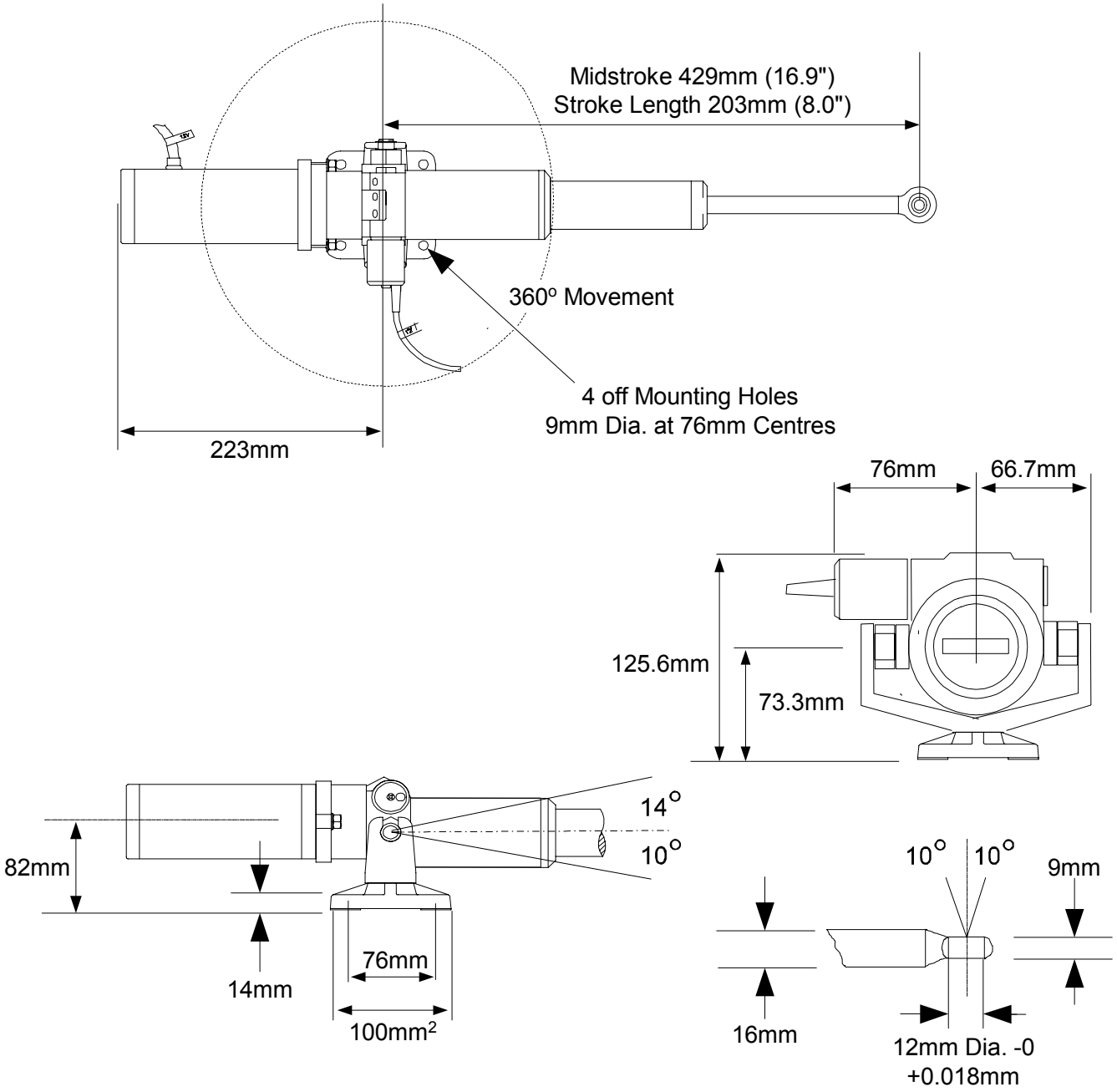
RAM T1 and T2 Hydraulic Linear Drives

RAM-T1-12V RAM-T2-12V RAM-T2-24V	Midstroke 575mm (22.6”)
½ Max. Rudder Angle	Tiller Arm
35°	214mm (8.4”)

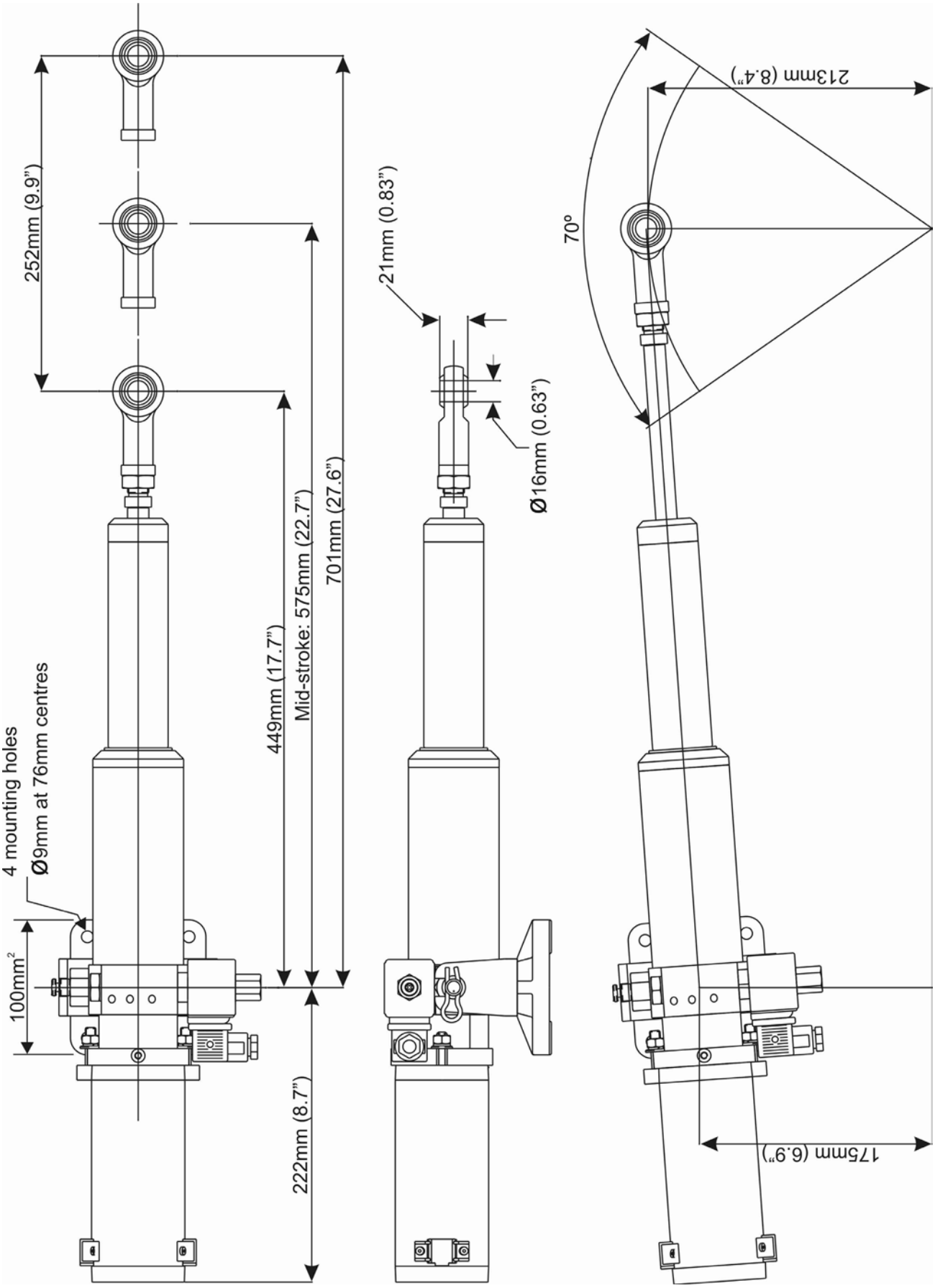
RAM T3 Split Hydraulic Linear Drive

RAM - T3-24V	Midstroke 755mm (29.7”)
½ Max. Rudder Angle	Tiller Arm
35°	257mm (10.2”)

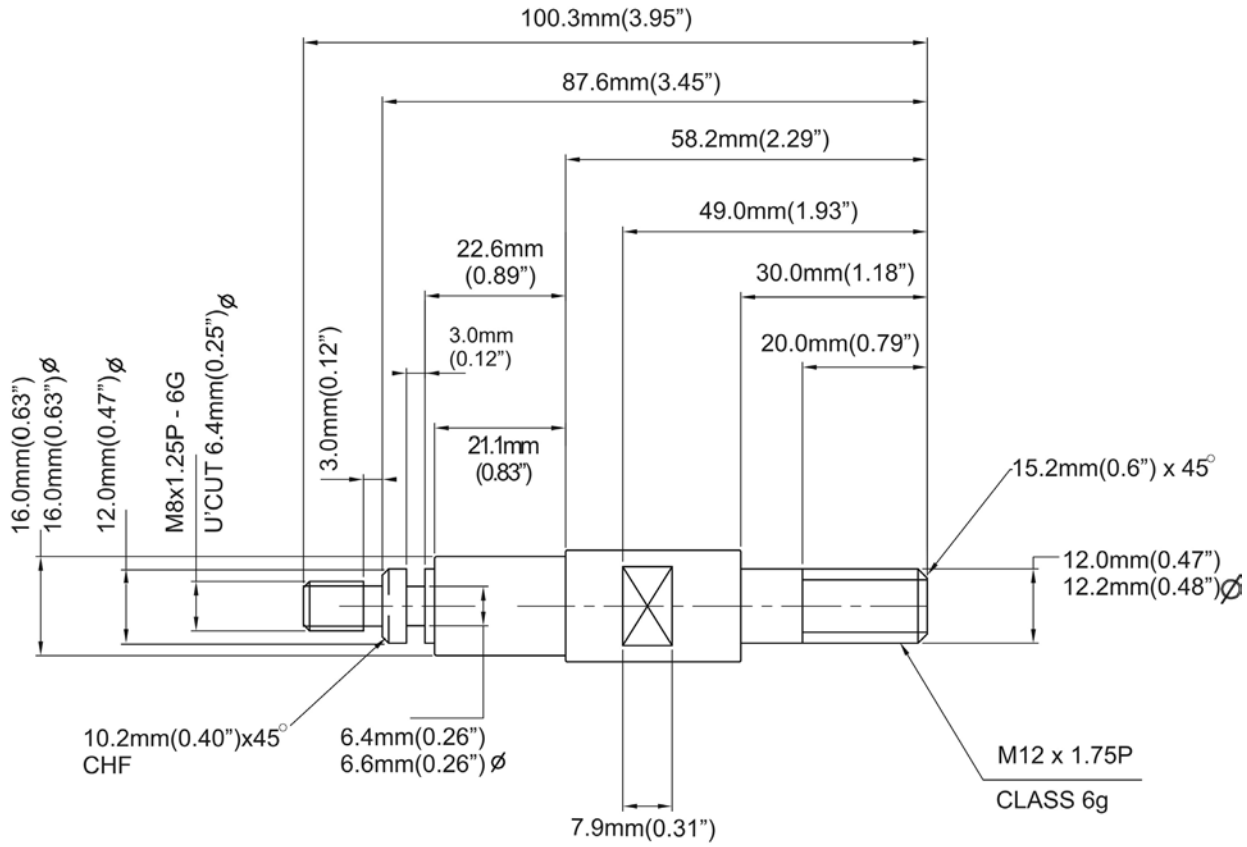
hydraulic ram drive dimensions (RAM-T0-12V)

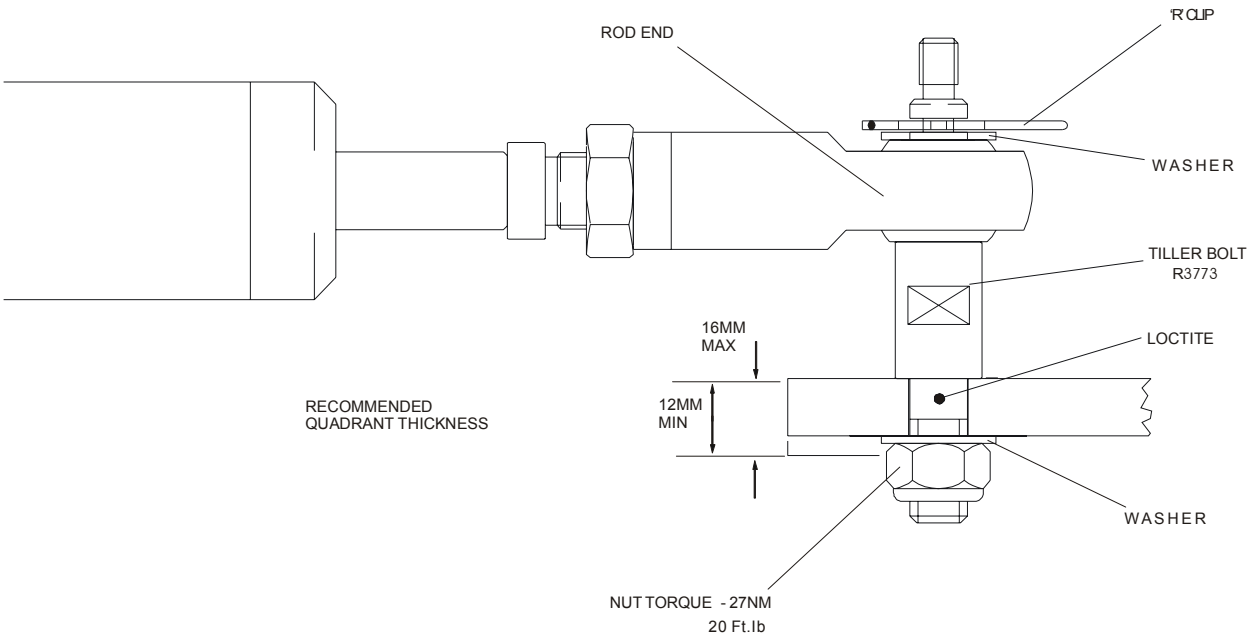


hydraulic ram drive dimensions (T1-12V, T2-12V, T2-24V)

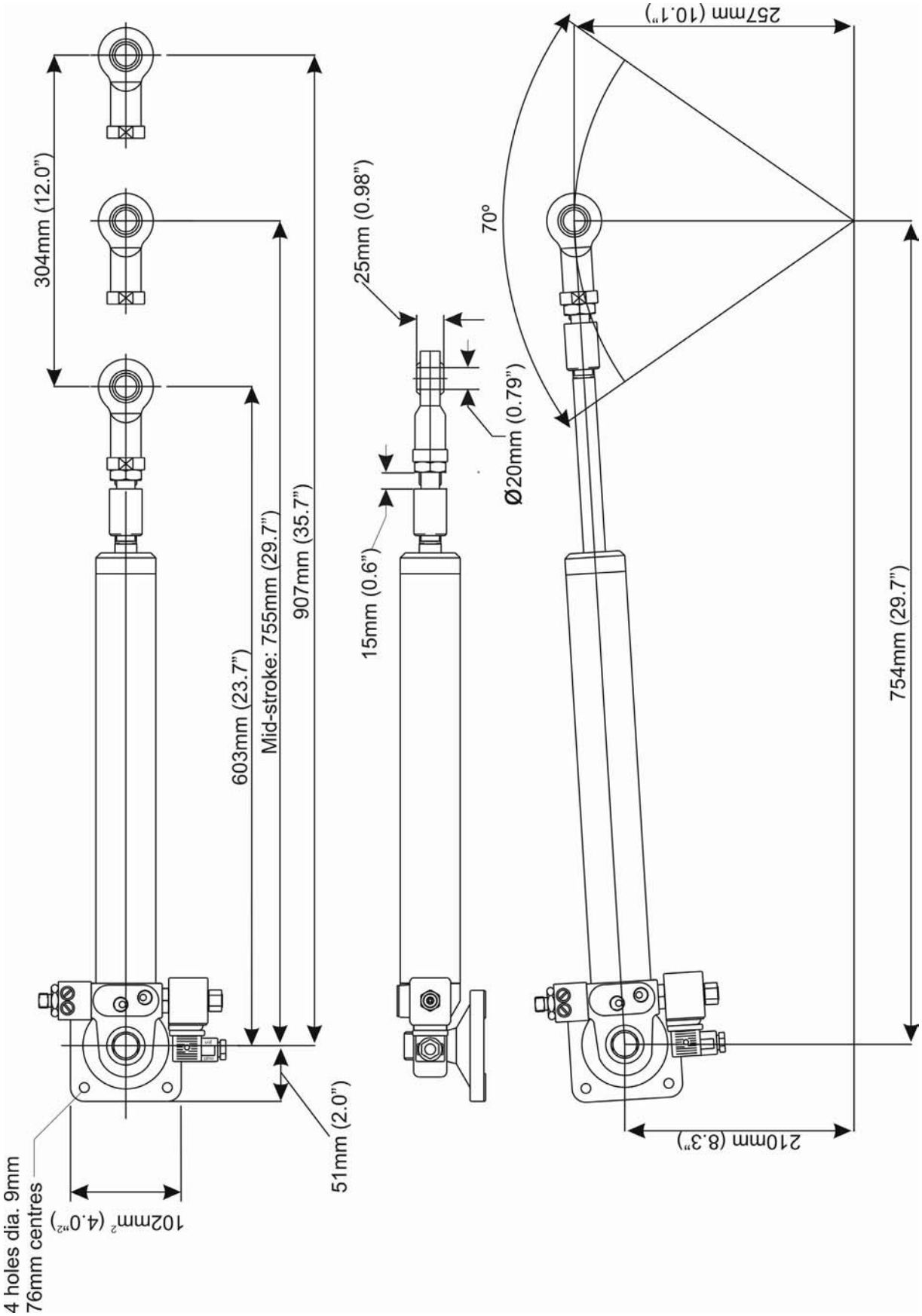


type 1 and 2 rose joint and am bolt detail

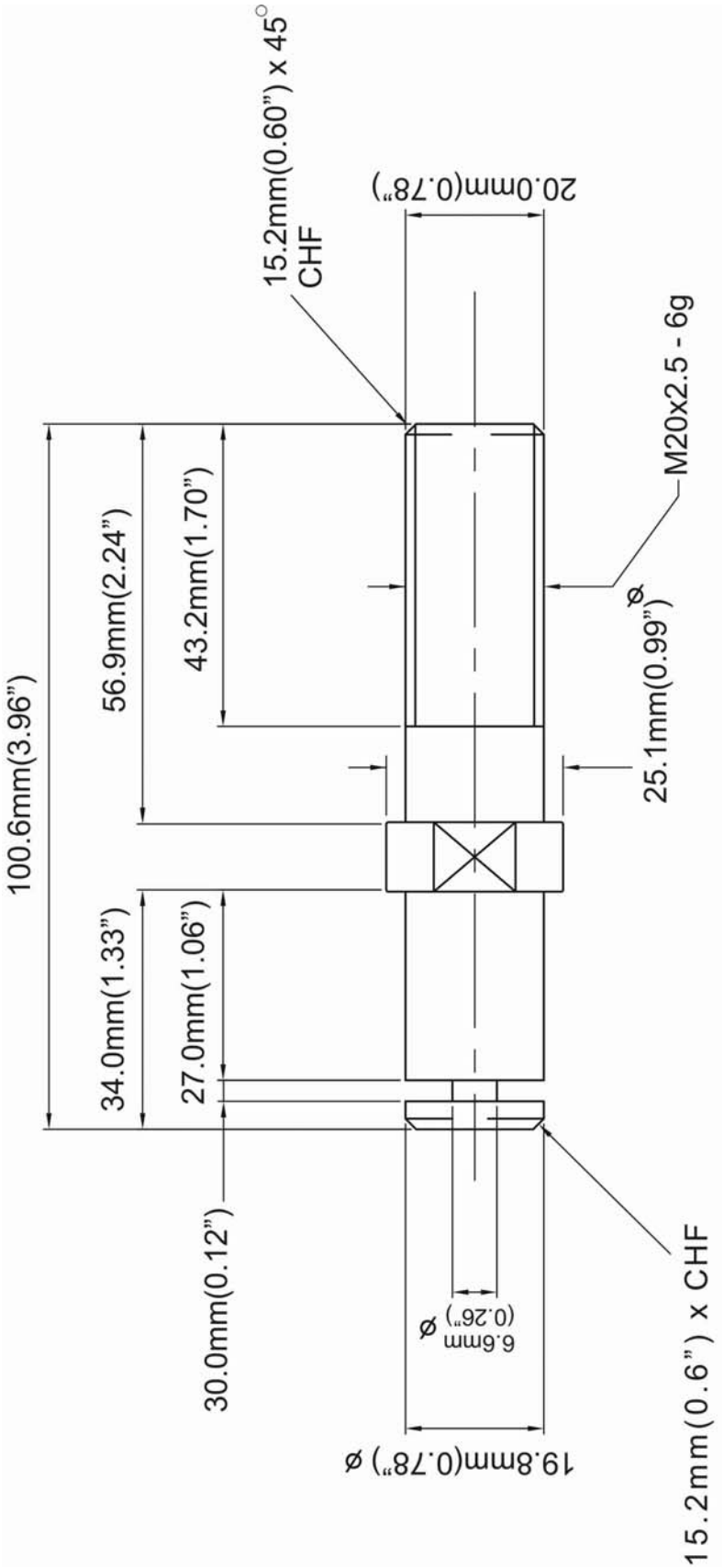




size 3 hydraulic ram drive dimensions, 24V



type 3 ram bolt detail



ram drive unit installation

Note: General consideration must be given to the steering system and its geometry before starting the installation. Many factors must be contemplated for a practical solution; the information given here is for guidance only, although where a maximum or minimum value is given this must be adhered to. It is essential that the unit be installed in a fully functional steering system, with no backlash or stiffness when operating. Rectify any steering problems before installation of the ram drive unit or the autopilot will not function correctly.

key points on installation

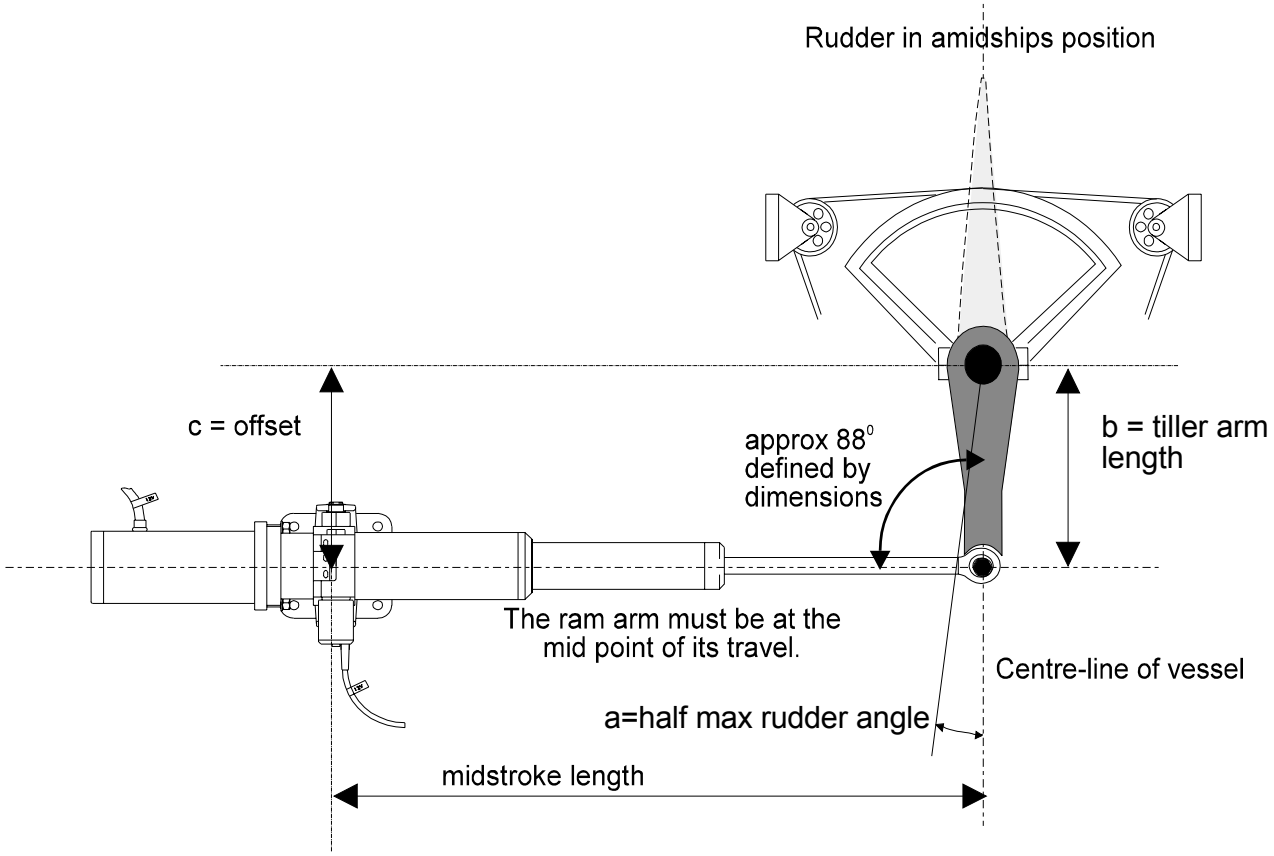
- Check that the steering gear is in good condition. Rectify any steering defects prior to installation of the ram.
- The ram drive unit must be secured onto a flat, rigid base. It maybe necessary to construct a platform section for the mounting plate. For angled rudderstocks, an angled platform section will have to be constructed.
- All setting-up and aligning of the ram drive unit with the steering system should be carried out with the rudder in the amidships position and the ram arm at the centre point of its travel.
- The angle between the ram arm and the tiller arm should be as shown in the following diagrams.
- The ram arm should ideally be at right angles to the rudderstock. The ball-joint on the end of the ram arm will allow a **MAXIMUM** of ±9° of vertical misalignment.

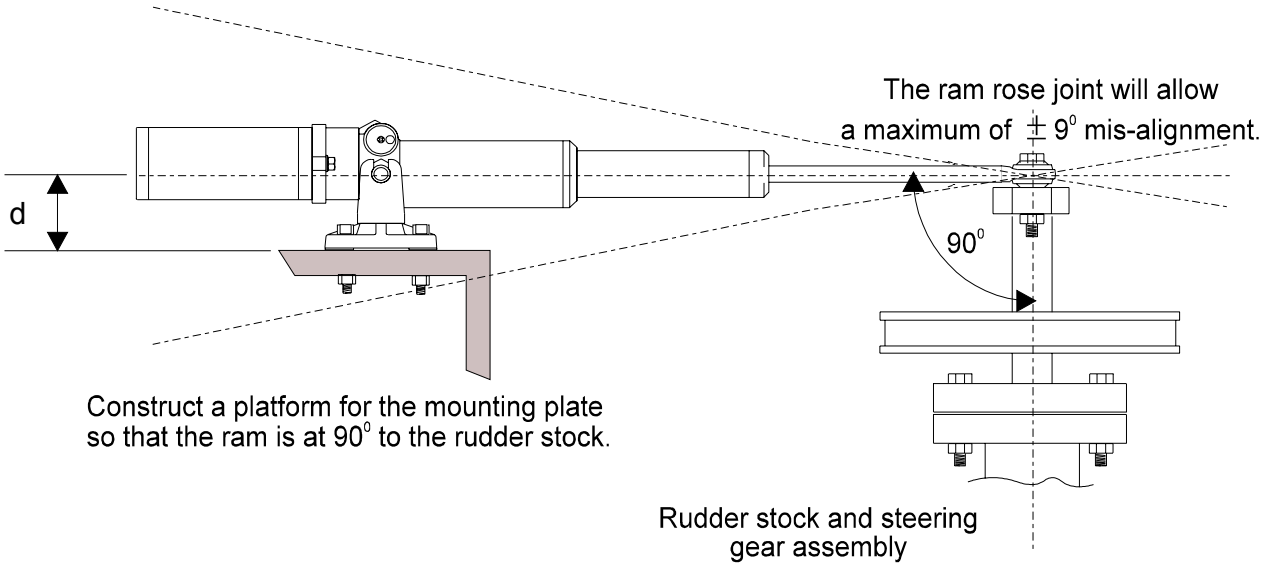
Caution: For Type 3 Ram Reservoir Installation, do not turn the black reservoir tap on or attempt to move the piston rod until all of the following are completed:

- The base foot of the ram and pump has been bolted into position.
- The reservoir has been fixed to a bulkhead above the ram and pump.
- The sealed reservoir transit cap has been replaced by the breather cap supplied.
- The reservoir has been filled with the oil supplied.

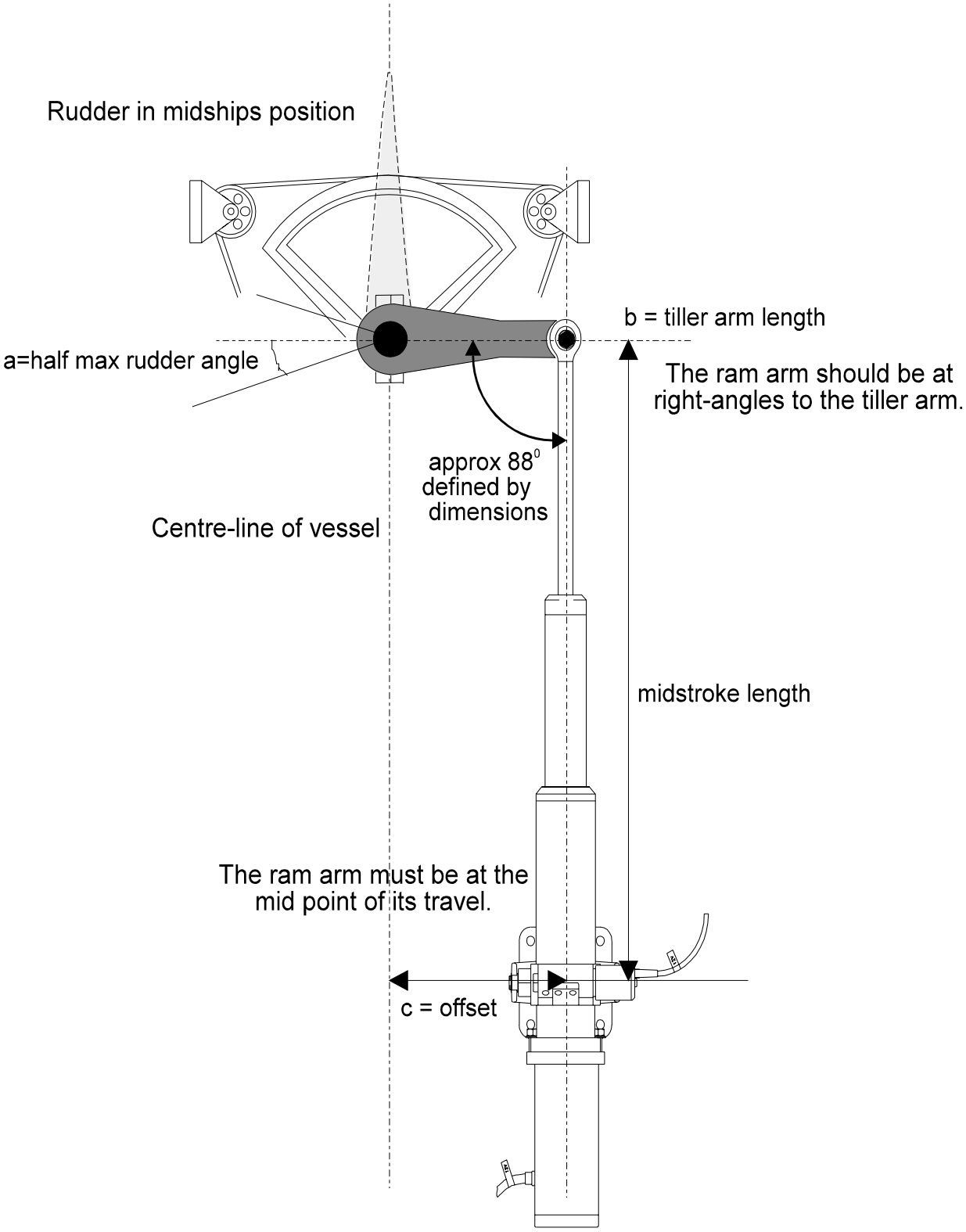
When the checks listed above have been verified, the reservoir tap can be switched to the **'ON'** position allowing the oil to flow between the reservoir and the pipe. (Tap "**ON**" position is in-line with the pipe).

layout of a typical ram drive unit




The ram rose joint will allow
a maximum of ± 9° mis-alignment.
d
90°
Construct a platform for the mounting plate
so that the ram is at 90° to the rudder stock.
Rudder stock and steering
gear assembly

ram mounted parallel to vessel's centre-line



ram mounted parallel to vessel's centre-line

key points on installation

- Make sure that the rudder angle is limited by the rudder stops and not the limit of travel of the ram arm. Failure to comply will damage the unit and invalidate the warranty.
- Make sure that there is sufficient space at each end for the ram arm to extend fully. The ram stroke length is given in the tables on **Page 13** of this manual.
- Check for full movement and security of the steering gear before applying any power to the autopilot system. Refer to the installation checklist in the calibration section of this handbook.

mounting a hydraulic linear ram on a vertical bulkhead

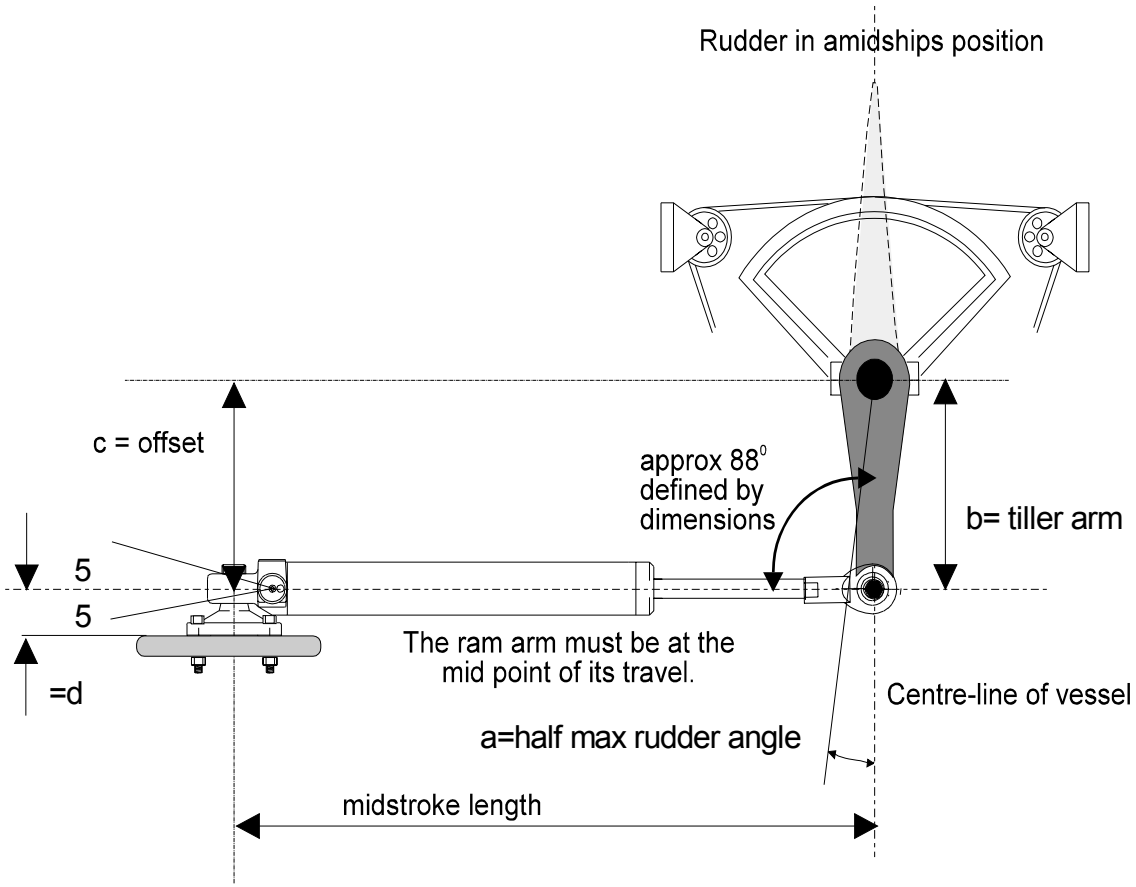
Due to the restricted movement of the ram mounting foot base (+14°/-10° for the Size 1 and 2 rams and ±5° for the Size 3 ram), it is important that the maximum rudder angle is carefully measured and the positioning of the ram, tiller arm length and offset are carefully followed from the diagrams on the following page.

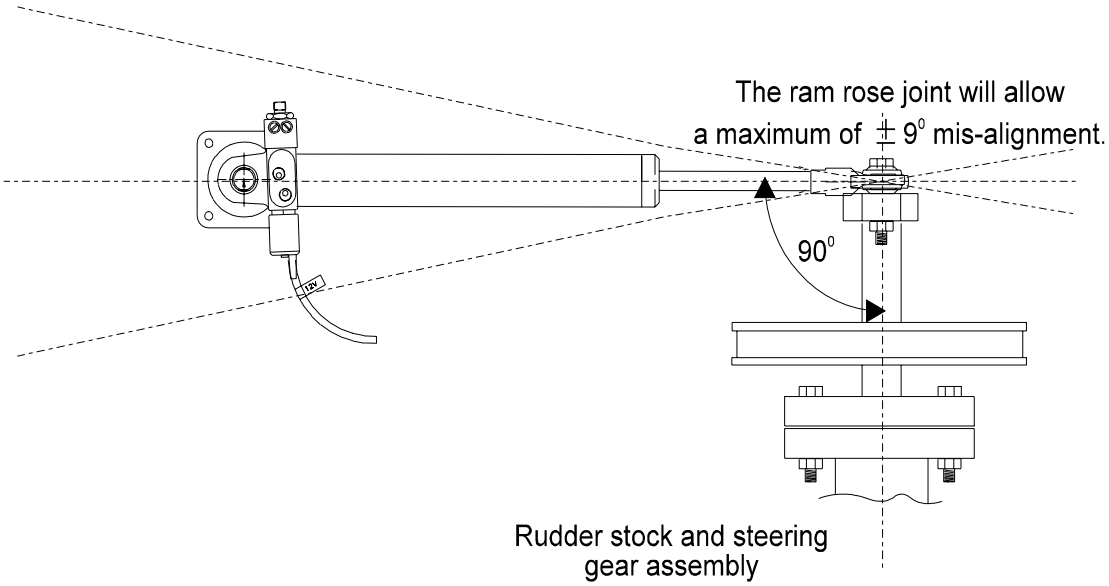
Caution: Failure to comply with these dimensions may cause premature failure of the ram and place great stress on the structure of the vessel.

Note: The Size 1 and 2 Linear Rams may be mounted in any orientation, without the need to fit an external reservoir. The Size 3 Linear Rams requires an external reservoir which must be positioned such that the reservoir is always higher than the drive unit at all normal angles of heel.

Care must be taken to ensure that the connecting pipes are not in anyway kinked or turned through any tight bends.

vertical bulkhead installation





splitting the ram drive unit

Note: when dealing with any hydraulic system great care must be taken to ensure that a high degree of cleanliness is observed and no dirt, moisture or foreign objects are allowed to enter the system. When filling or topping up the external reservoir only use a good quality ISO 10 hydraulic oil e.g., Q8 Dynobear 10 (10cSt at 40^0C).

It is not possible to split the following linear drives:

- RAM-T0-12V
- RAM-T1-12V
- RAM-T2-12V
- RAM-T2-24V

type 0, type 1 and type 2 units

Comprise a combined ram/pump, reservoir and hydraulic cylinder. These units cannot be split.

type 3 units

Are supplied as split units, connected by 1m (3ft) hoses. These can be supplied with quick connect couplings and pre-filled hoses. These units do not need to be bled.

Note: types 3 units with longer hoses are available from your dealer.

hydraulic drive pumps

description

The reversible hydraulic drive pump has a small high-speed pump driven by a 12V or 24V dc permanent magnet motor. The pump has pilot check valves to prevent back driving and a pilot operated reservoir valve to enable the unit to drive balanced or unbalanced cylinders. The unit has port and starboard ¼ inch BSP service ports and a ¼ inch BSP reservoir port.

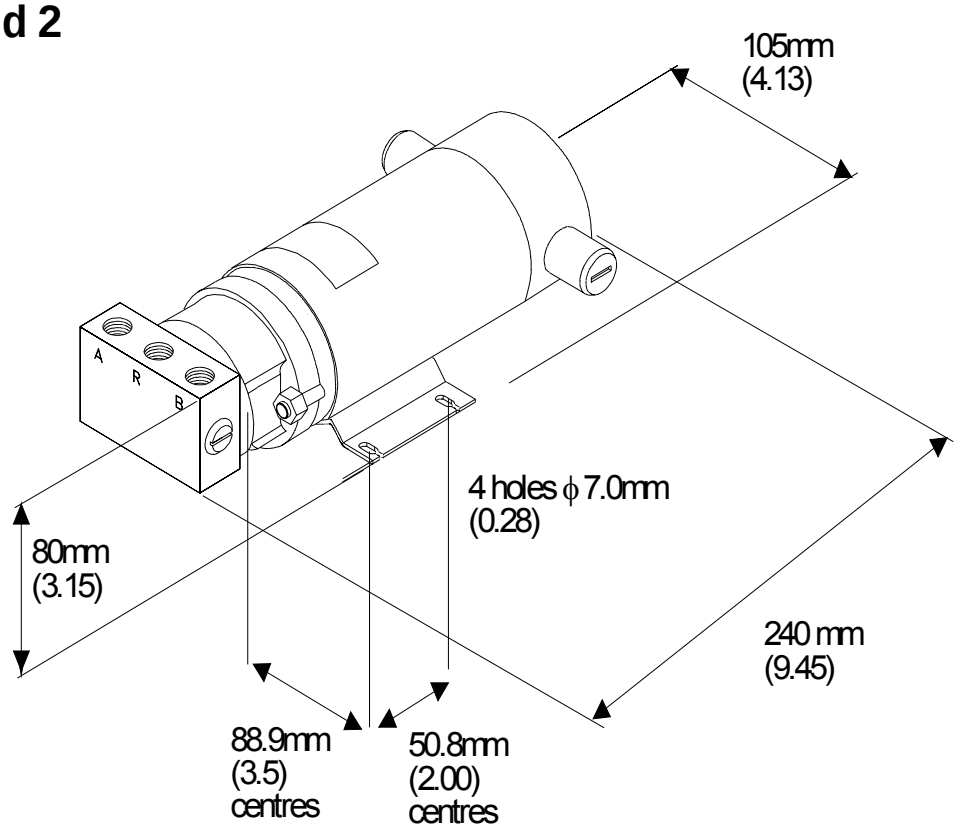
pump data

Hydraulic Pump Type	PMP-T1-12V	PMP-T2-12V	PMP-T3-24V
Pump Type	Reversible dc motor	Reversible dc motor	Reversible dc motor
Supply Voltage	12V dc	12V dc	24V dc
Typical Operating Current Range	5A to 17.5A	5A to 22.5A	6A to 17.5A
Maximum Pressure	1000 psi	1000 psi	1000 psi
Maximum Flow Rate at continuous duty motor loading	750 cc/min (46 in^3/min)	1420 cc/min (87 in^3/min)	1980 cc/min (121 in^3/min)
Cylinder Capacity	100cc to 300cc (6.1 to 18.3 in^3)	275cc to 550cc (16.8 to 33.6in^3)	525cc to 750cc (32 to 46in^3)
Weight	3 kg (6.6 lbs)	3 kg (6.6 lbs)	4 kg (8.8 lbs)

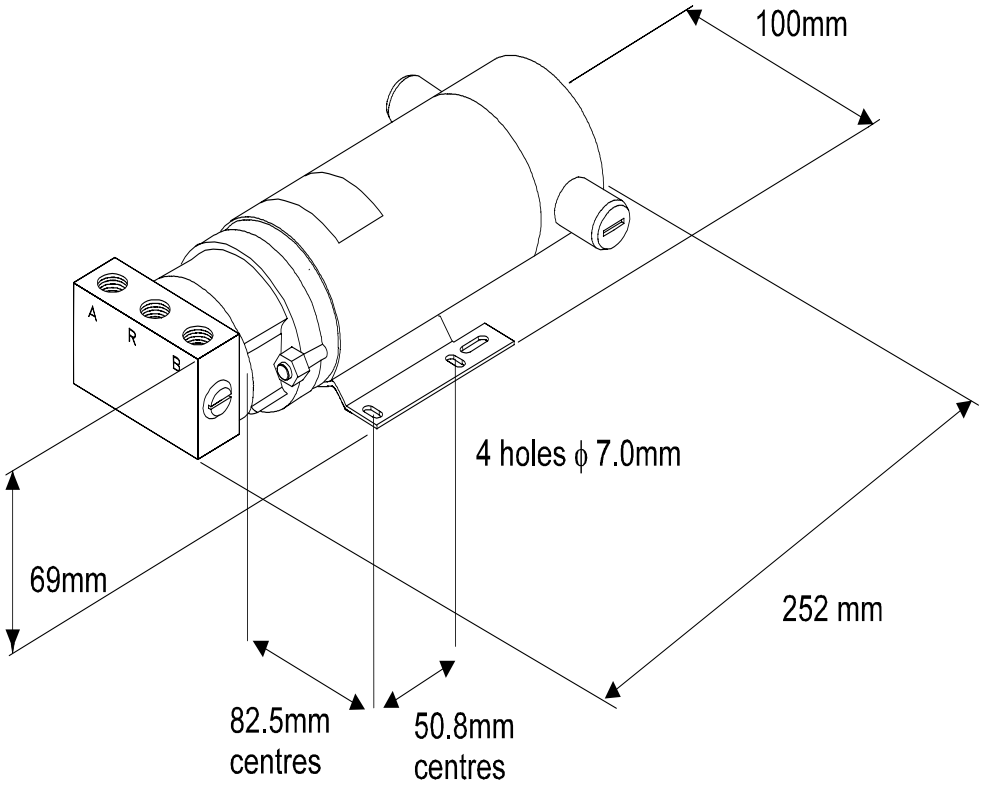
key points on installation

- A position should be chosen convenient for the steering system hydraulic delivery lines.
- The site should be rigid and flat to prevent excess vibration.
- Shielded from the direct effects of the elements.
- Minimise the lengths of the hydraulic lines from the pump to the cylinder and where possible, the pump motor supply cables.

hydraulic drive pump dimensions type 1 and 2



type 3



hydraulic drive pump installation

Note: When dealing with any hydraulic system great care must be taken to ensure that a high degree of cleanliness is observed and no dirt, moisture or foreign objects are allowed to enter the system. When bleeding your hydraulic steering system only use a good quality ISO10 hydraulic oil, e.g. Q8 Dynobear or equivalent (10cSt at 40^0C).

The procedure for installing the hydraulic drive pump is as follows:

1. Drain the steering system from the lowest point, usually at a cylinder coupling.

2. Fit T-pieces into the port and starboard delivery lines, couple the lines to the appropriate service ports of the pump using flexible hydraulic hose.

3. Couple the reservoir port to the reservoir/balance line from the helm units. A low pressure, transparent plastic tube can be used.

Note: Ensure that this line rises gradually with no down turns.

4. Refill the steering system as recommended by the manufacturer, using clean hydraulic fluid.

5. Fill the cylinder by temporarily removing the cylinder couplings and hoses at each end. Refit the hoses securely.

6. Starting at the highest helm unit, fill the helm reservoir.

7. Slowly turn the steering wheel two turns to port and then to starboard, checking the level of fluid in the helm unit reservoir at all times.

8. Next, turn the wheel fully in one direction until a slight pressure is felt, continuously monitor the reservoir level.

9. Repeat in the opposite direction and continue in this manner until topping up is no longer necessary.

10. When satisfied that the steering is fully bled manually, apply power to the pump unit.

11. Turning the wheel fully from lock to lock will cause the pump to self-purge.

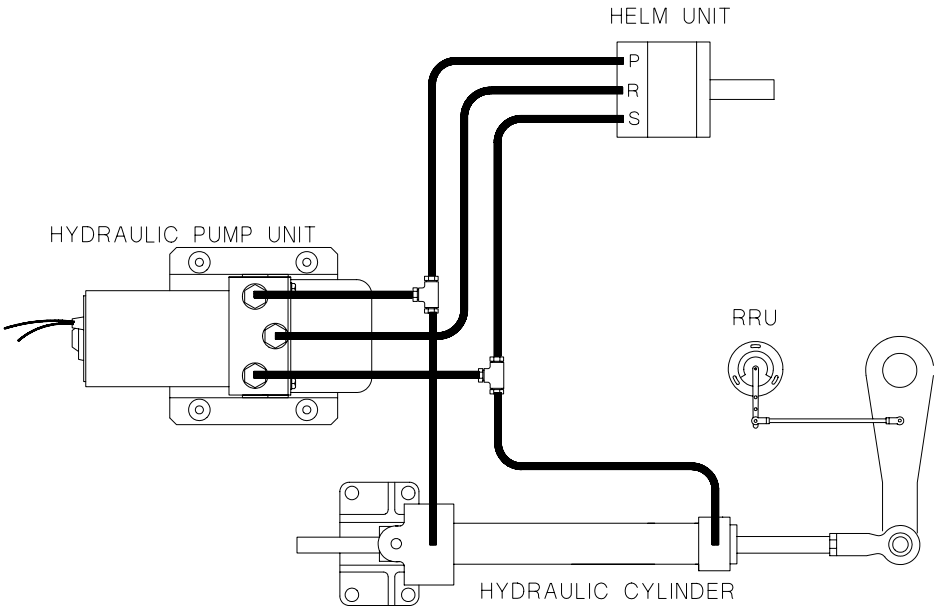
12. Check the fluid level in the helm unit reservoir.

13. When the system appears to be fully functional, with the pump running and the helm hardover check for leaks.

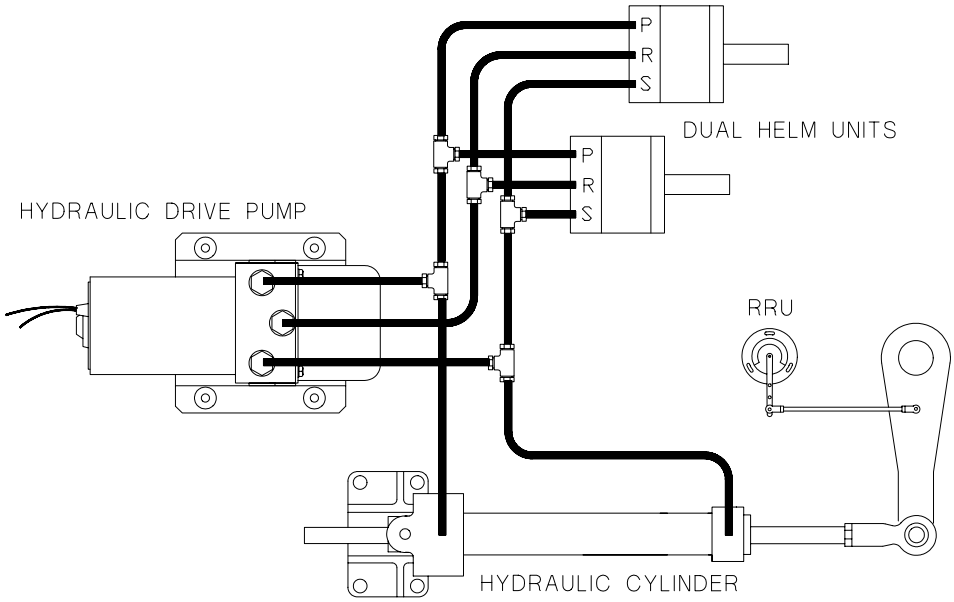
14. Secure all hoses and cables to prevent damage.

hydraulic drive pump installation examples

single station system example

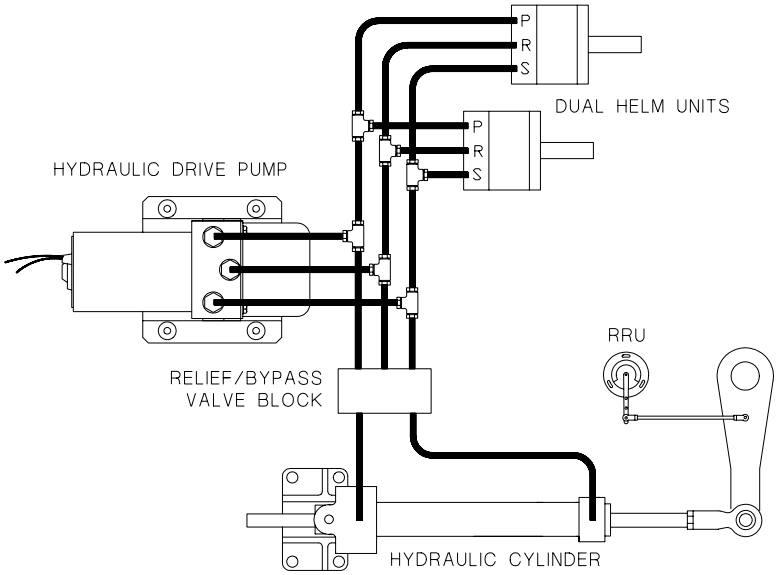


dual station system example

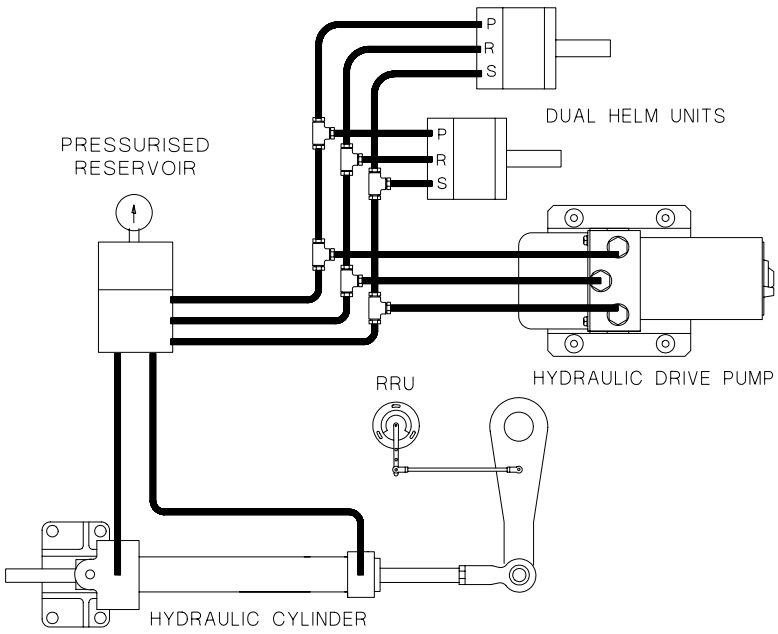


hydraulic drive pump installation examples

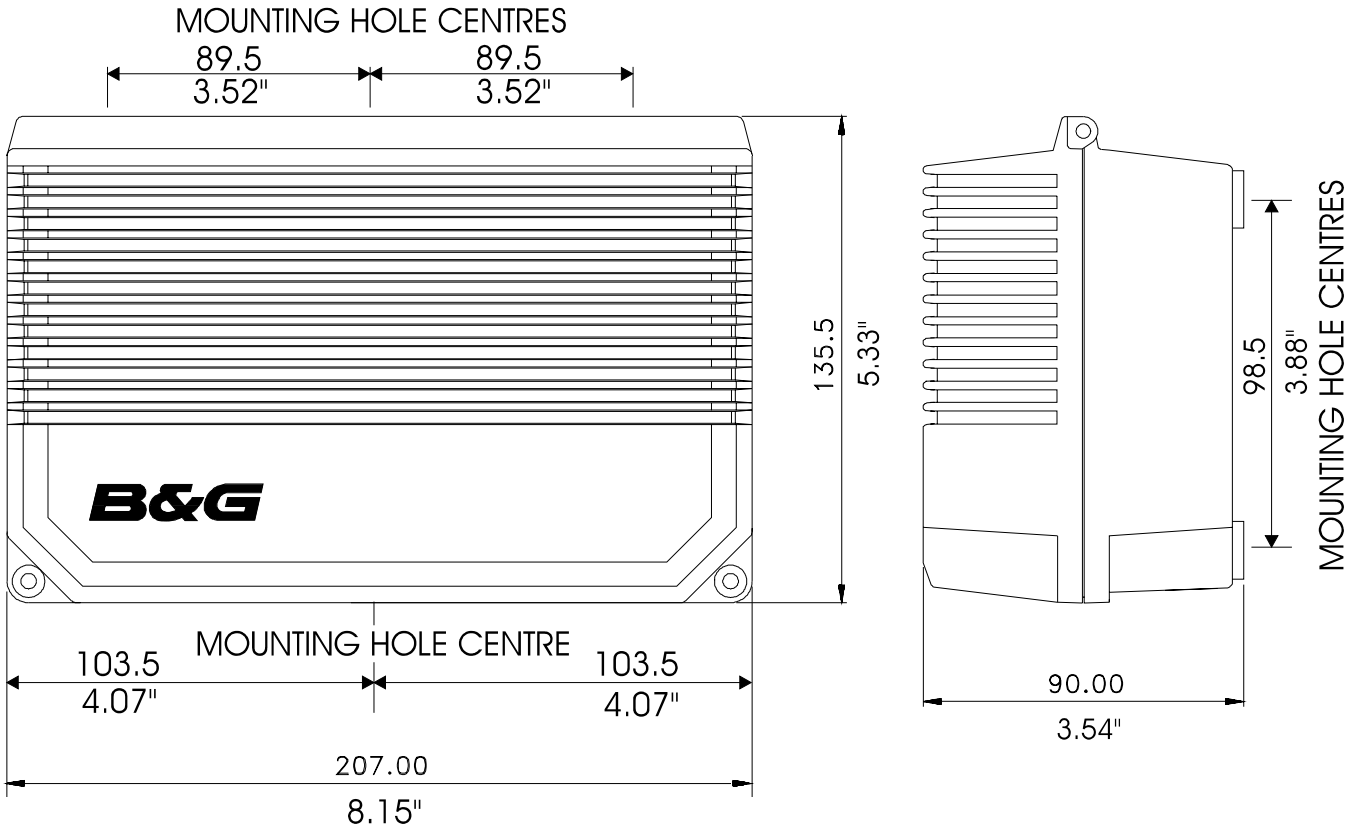
dual station system with bypass example



dual station pressurised system example



advanced control processor unit



description

The Advanced Control Processor (ACP) Unit contains all the electronics for the autopilot operation and control of the rudder drive options. It is designed to be mounted on a vertical, flat, smooth surface. The unit has a hinged lid to provide easy access to the electrical connections.

siting the acp unit

- It is recommended that the ACP unit be mounted with the cable entries downwards. It must not be mounted with the cable entries uppermost as water may run down the cables and into the unit.
- Ensure that there is sufficient space to allow the unit to be hinged open to make connections to terminals inside, and that the hinges of the two halves of the case may be slid apart.
- Select a position sheltered from the direct effects of the environment and from physical damage.
- Do not mount the unit within 1m (3ft) of engines, starter motors and cables, and other cables carrying heavy currents, etc., or 3m (10ft) of Radar or SSB installation cables.

mounting procedure

- Undo the two screws at the corner of the unit, and open fully.
- The hinges are designed to come apart. This enables the electronics to be split from the base of the unit; i.e. the connection and terminal blocks.
- Disconnect the cables between the two halves of the casing.
- Firmly push the two halves of the computer unit apart.
- Using the base of the unit as a template, mark the positions of the three mounting screw holes.
- Using the self-tapping screws provided secure the base of the unit in position.
- Push the two halves of the unit together again and reconnect the cables.

acp unit installation

cable and connection information

emc compliance

B&G equipment is designed to be operated in leisure craft. Every care has been taken in its design and testing to ensure compliance with the European EMC Directive, provided it is installed and operated in accordance with the instructions as supplied, and the units and cables used are unmodified. Specific attention is drawn to the requirements to maintain cable separation, where stated.

Transmissions from poorly installed or maintained Single Sideband equipment may adversely affect the functioning of this equipment. On vessels fitted with SSB, it is essential that such equipment is installed following good installation practice and as recommended by the manufacturer.

general wiring notes

- Do not apply power to the pilot system until all units are connected and the wiring has been checked.
- Where spade connectors are supplied, always use the correct crimping tool to attach them to the cable. This is extremely important where high currents are to be passed; i.e. rudder drive unit supply cables.
- Keep supply cables as short as possible to reduce the possibility of a voltage drop in the cables.
- Always fit a fuse or circuit breaker in supply cables. It is recommended that heavy-duty power cables are protected by a 25A MCB.
- Clearly identify each cable to prevent incorrect connection.
- Cables that have a screening braid must have the screen connected as shown on the connection diagrams.
- All Pilot cables should be routed at least 1m (3ft) from cables or components that carry or generate high currents; e.g. alternators, starter motors, trim-tab cables, etc.
- To minimise interference avoid routing Pilot cables alongside high power radio or radar cables.
- To prevent damage to cabling always secure in position using cable clips or tie-wraps. Where cables pass through bulkheads always protect the cable from chafing by fitting grommets.
- Do not allow cables to rest in the bilges where prolonged immersion in water, fuel, etc. may occur.
- Always fit splash covers and lids on processors, computer units and junctions boxes, where supplied.

pilot drive unit cables

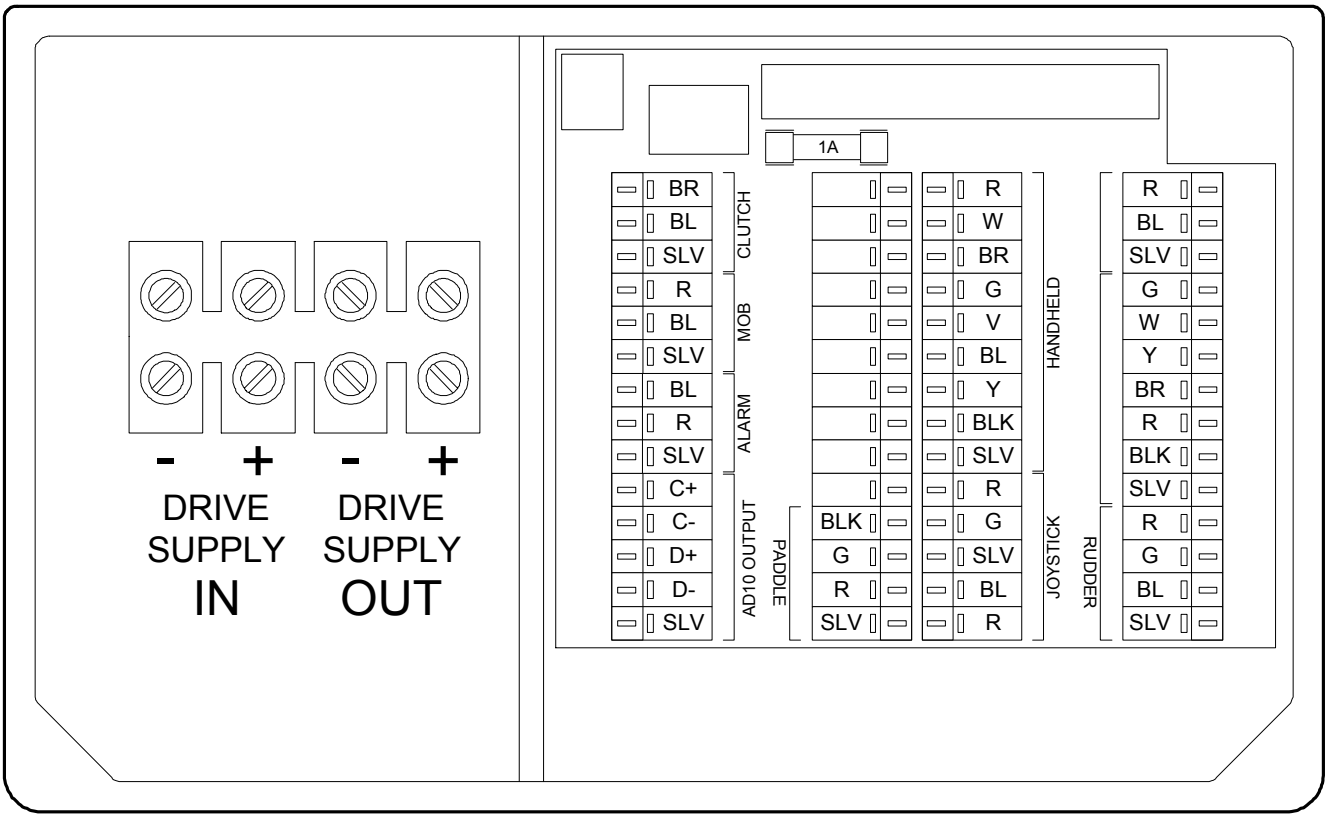
all rudder drives - heavy duty power cables

Total Cable Length	B&G Cable Part No.	Copper Area	Cable Gauge
Up to 8m (26ft)	135-0A-128	4.0mm²	12 awg
Up to 12m (40ft)	Not available	6.0mm²	10 awg
Up to 20m (65ft)	Not available	10.0mm²	7 awg

linear drives - clutch/valve cables

Up to 9m (30ft)	135-0C-096	0.5mm²	22 awg
Up to 15m (50ft)	135-0B-096	0.5mm²	22 awg

acp unit terminal details



wire colour coding and abbreviations

Wiring Colours			
R	Red	V	Violet
BLK	Black	Y	Yellow
BL	Blue	O	Orange
BR	Brown	W	White
G	Green	SLV	Silver (Not Used)

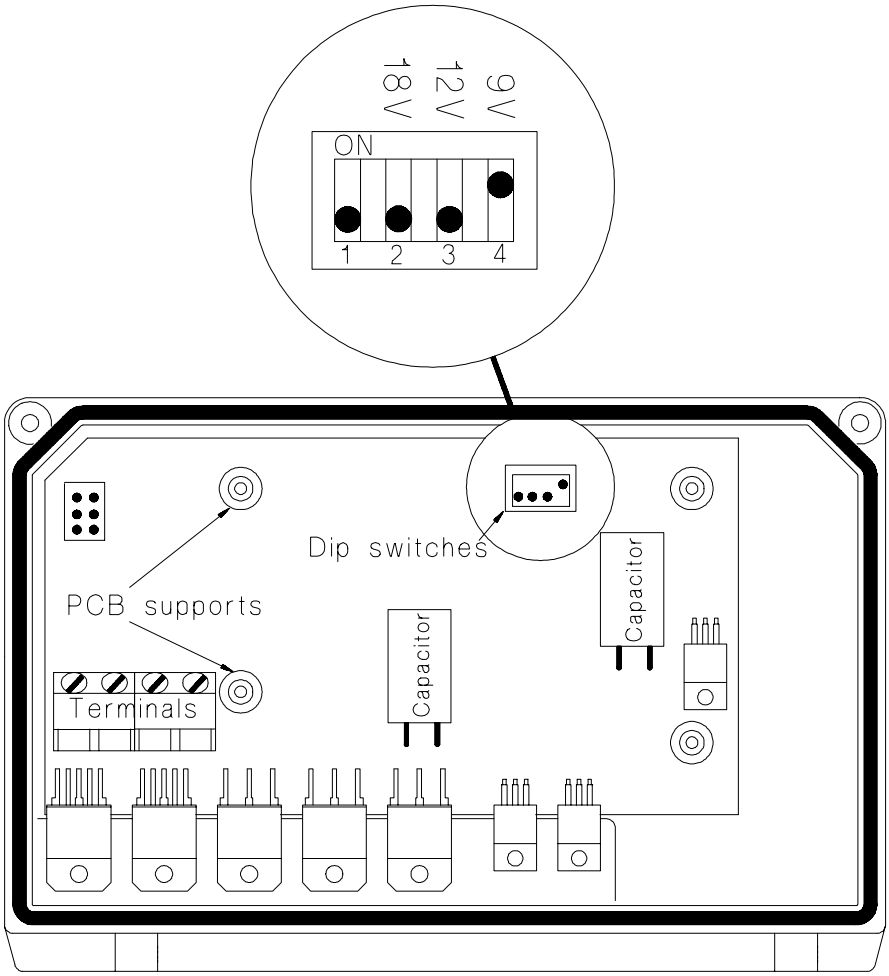
clutch voltage selection

The h1000 pilot computer unit can output different clutch/solenoid voltages depending upon the size of rudder drive unit fitted. The clutch/solenoid valve is only required for rams or rotary drive units. This is achieved by setting dip-switches on the computer drive PCB. Access to the switches is obtained by removing the four screws holding the computer PCB into the lid of the computer unit and then carefully lifting the PCB clear.

Set the switches as per the table below. The default setting is 9V, switch 4 **ON**, which is suitable for Size 0, 1, and 2 12V rams.

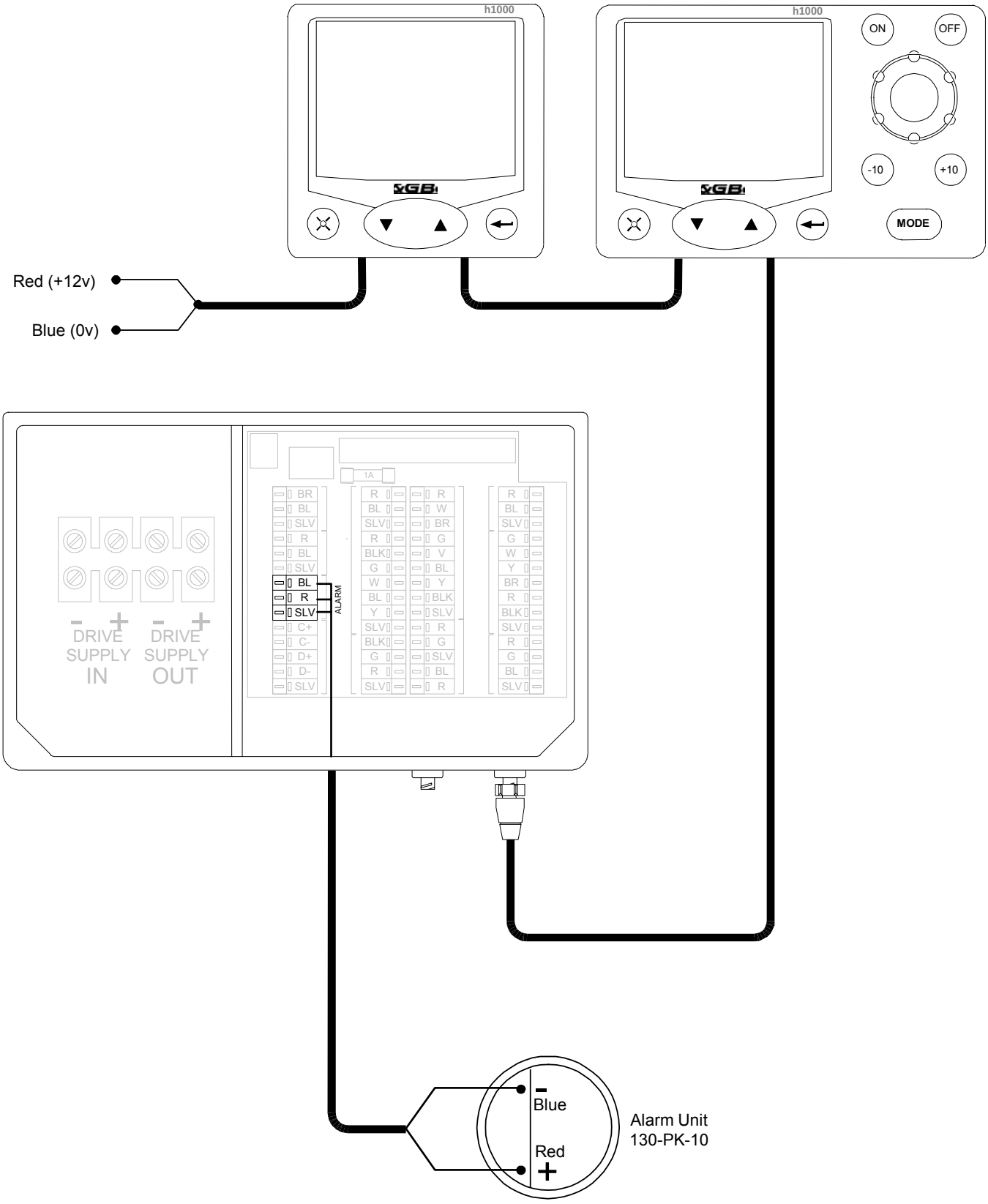
Dip Switch	Clutch Voltage	Drive Size / Type
1	24V	24V Rotary
2	18V	Size 2 and 3, 24V Rams
3	12V	12V Rotary
4	9V	Size 0, 1 or 2 12V Rams

acp dip switch location

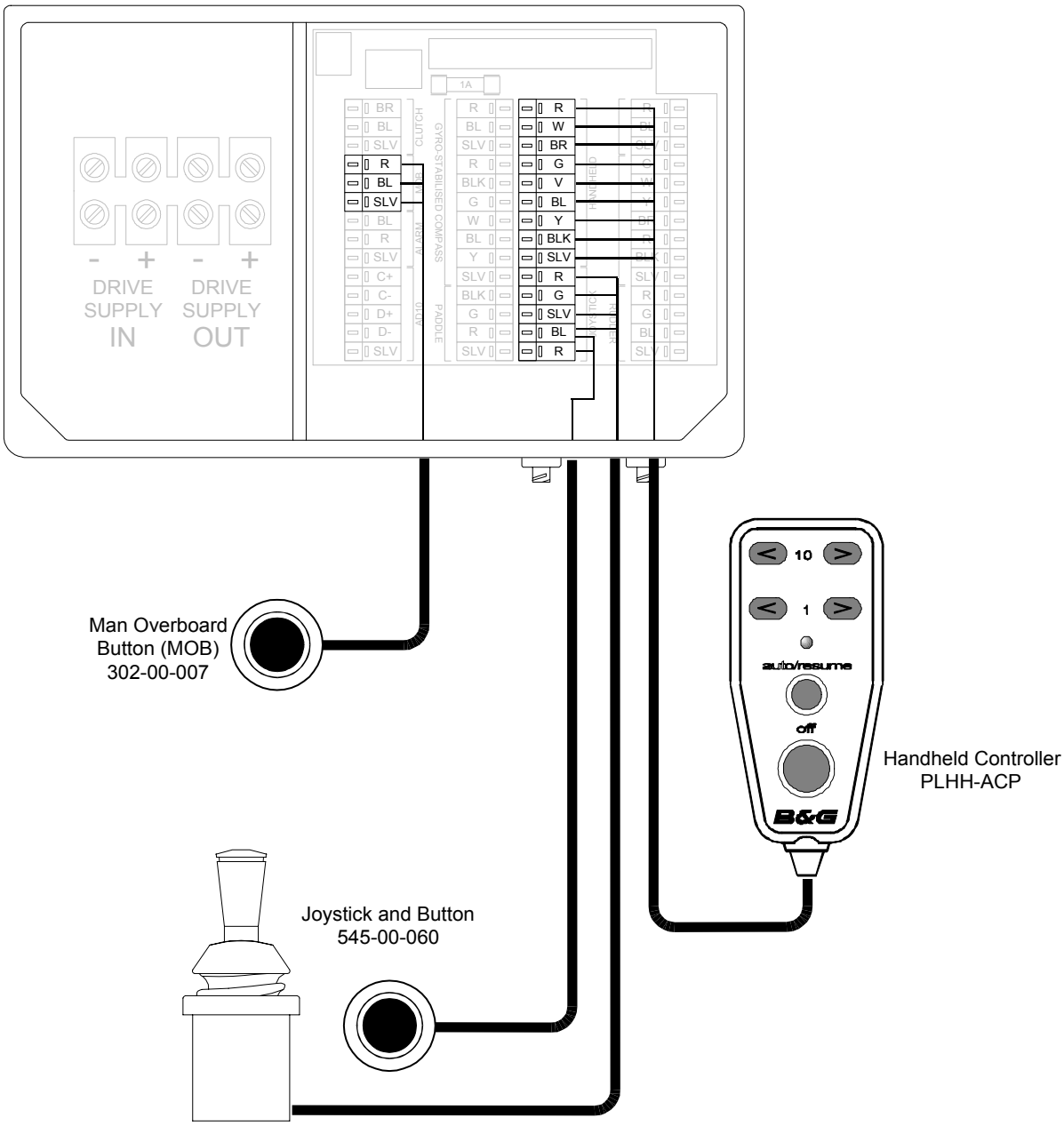


Note: When reassembling the computer unit ensure that the connector in the top left-hand corner of the PCB engages correctly.

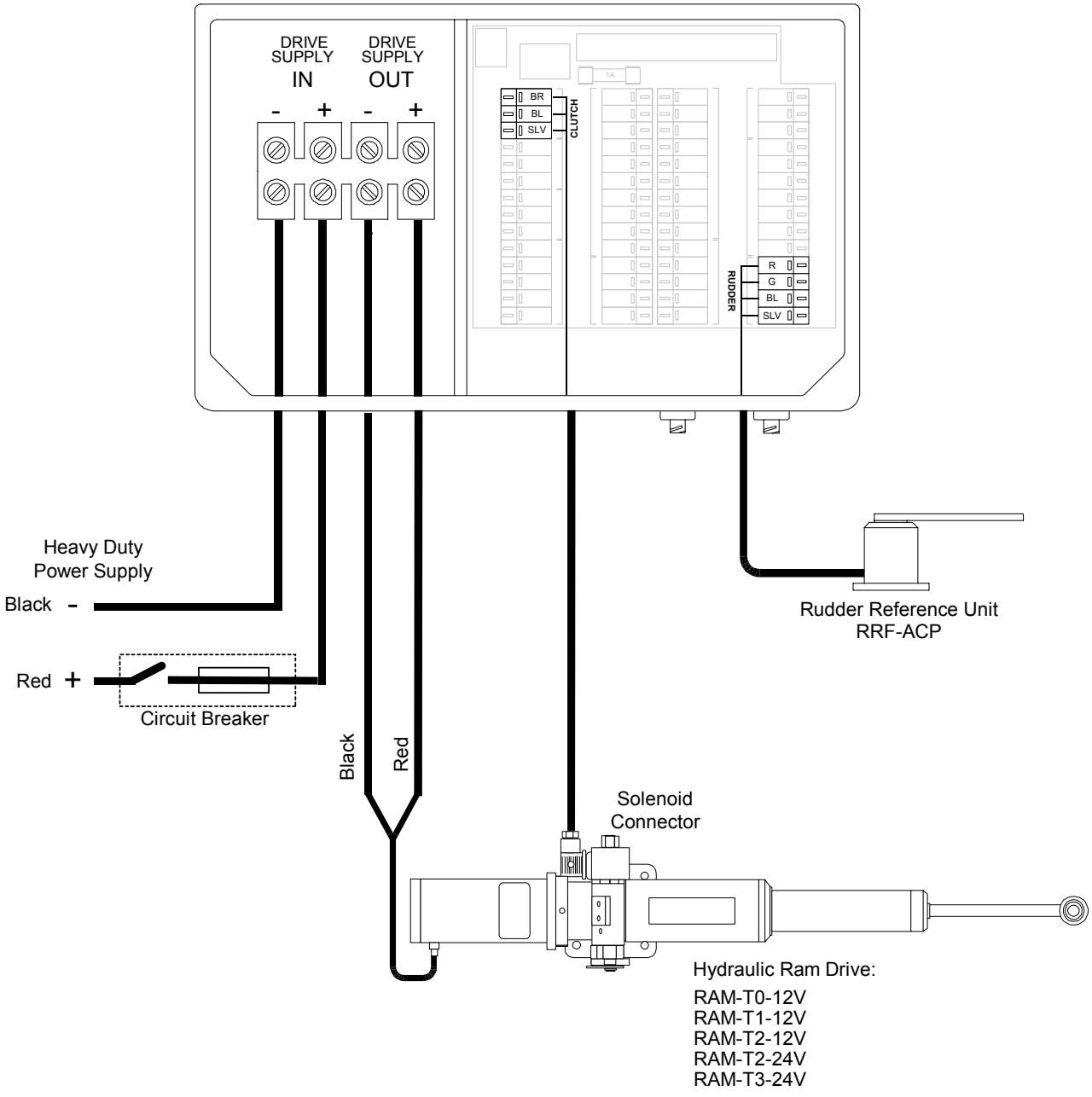
h1000 and alarm connections



hand-held, mob and joystick



hydraulic ram drive connections



ram solenoid wiring details

the following information applies to the size 0, 1, 2 and 3 blue rams only.

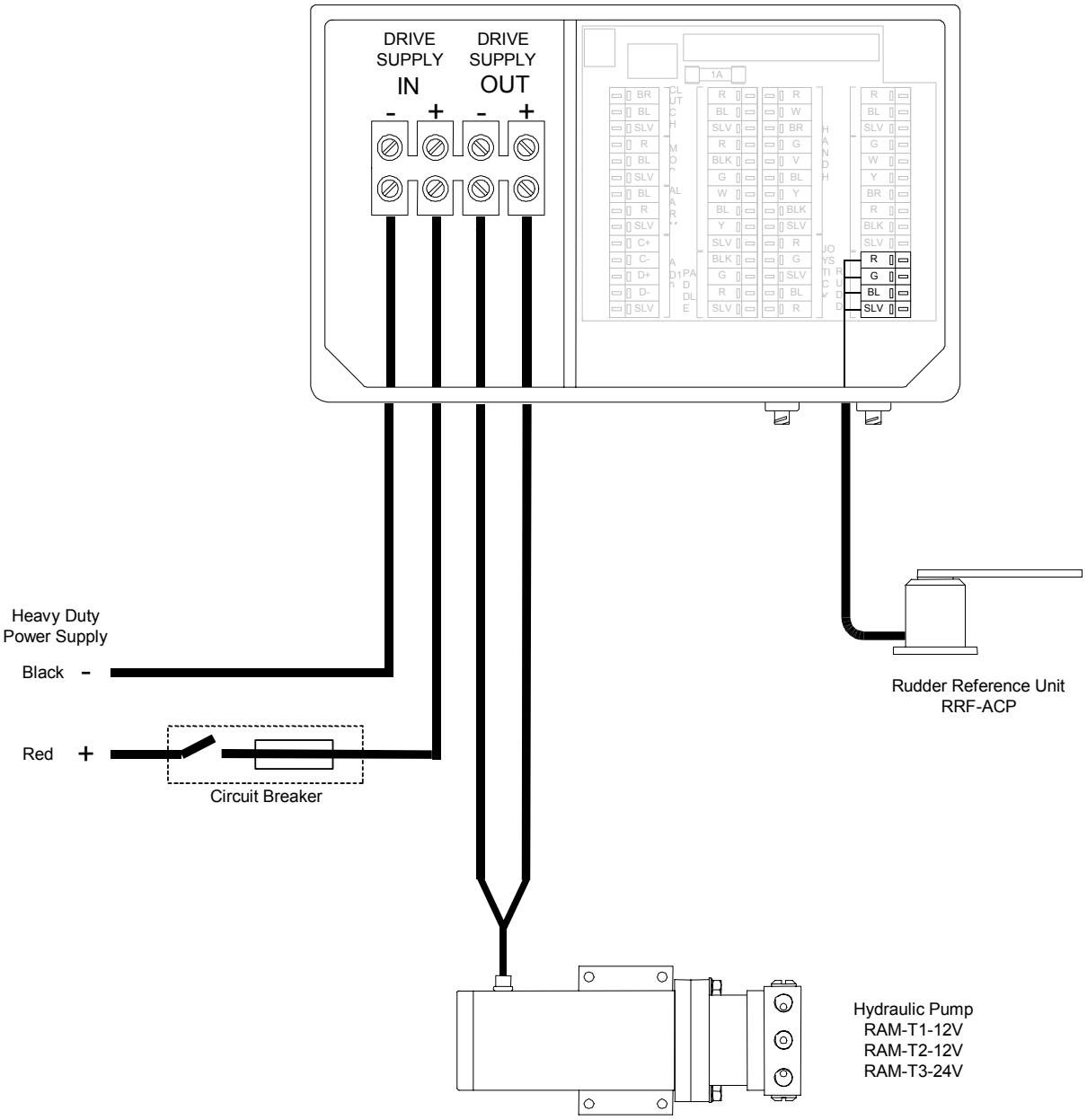
1. Remove the solenoid wiring connector by unscrewing the centre screw.
2. Remove the screw from the connector housing.
3. Remove the rubber gasket.
4. Use a small screwdriver through the screw hole to carefully push against the connector block. This will push the front of the connector block out ready for wiring.
5. Run the cable through the cable entry in the cover and then connect as follows:

Pin 1: **Blue Wire**
Pin 2: **Brown Wire**

6. The cable screen must be cut back and sleeved.

Refit the two halves of the connector together, tighten the plastic cable clamp nut, replace the rubber seal and fit the connector onto the solenoid using the centre screw to fully secure it.

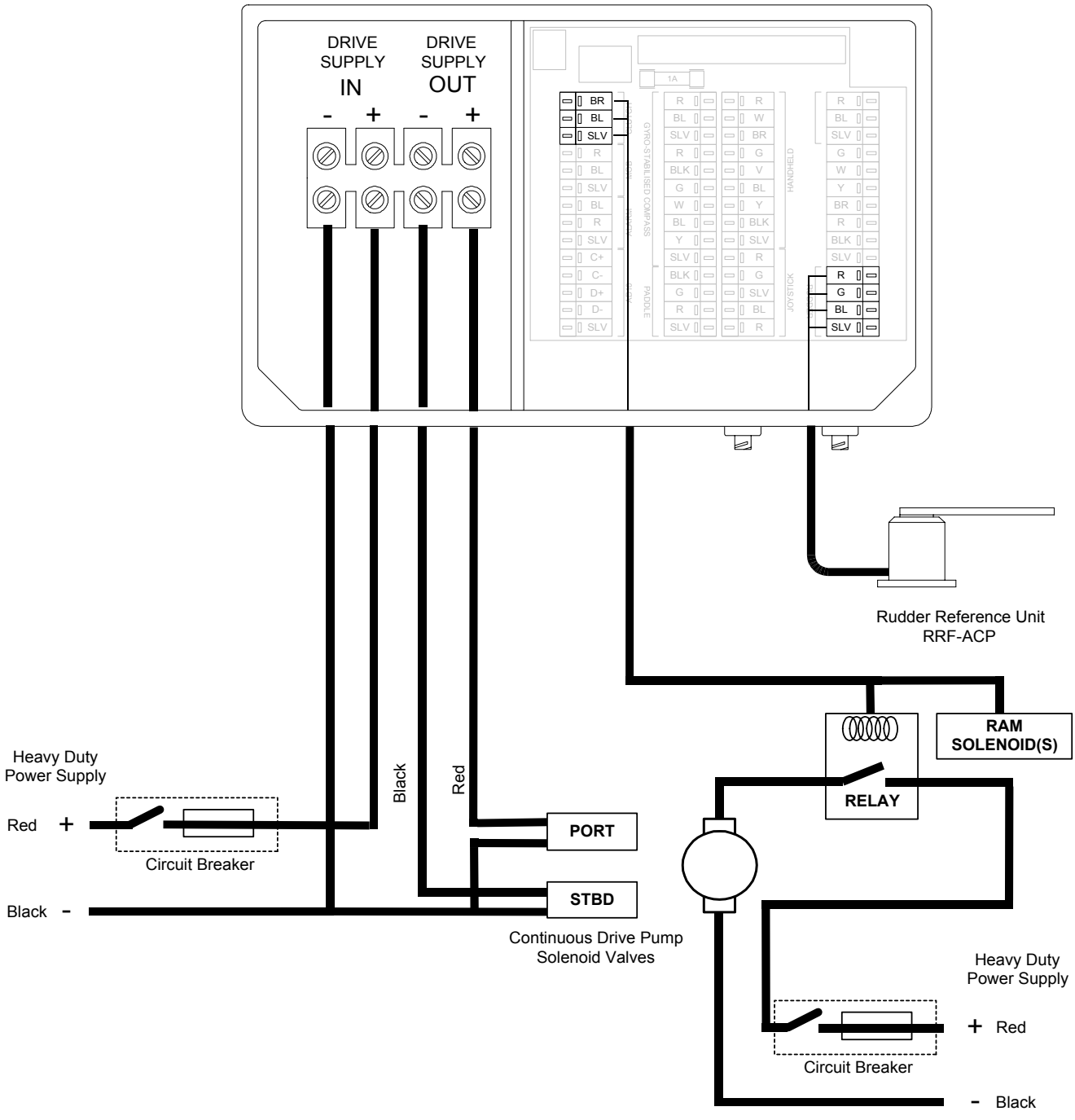
hydraulic pump connections



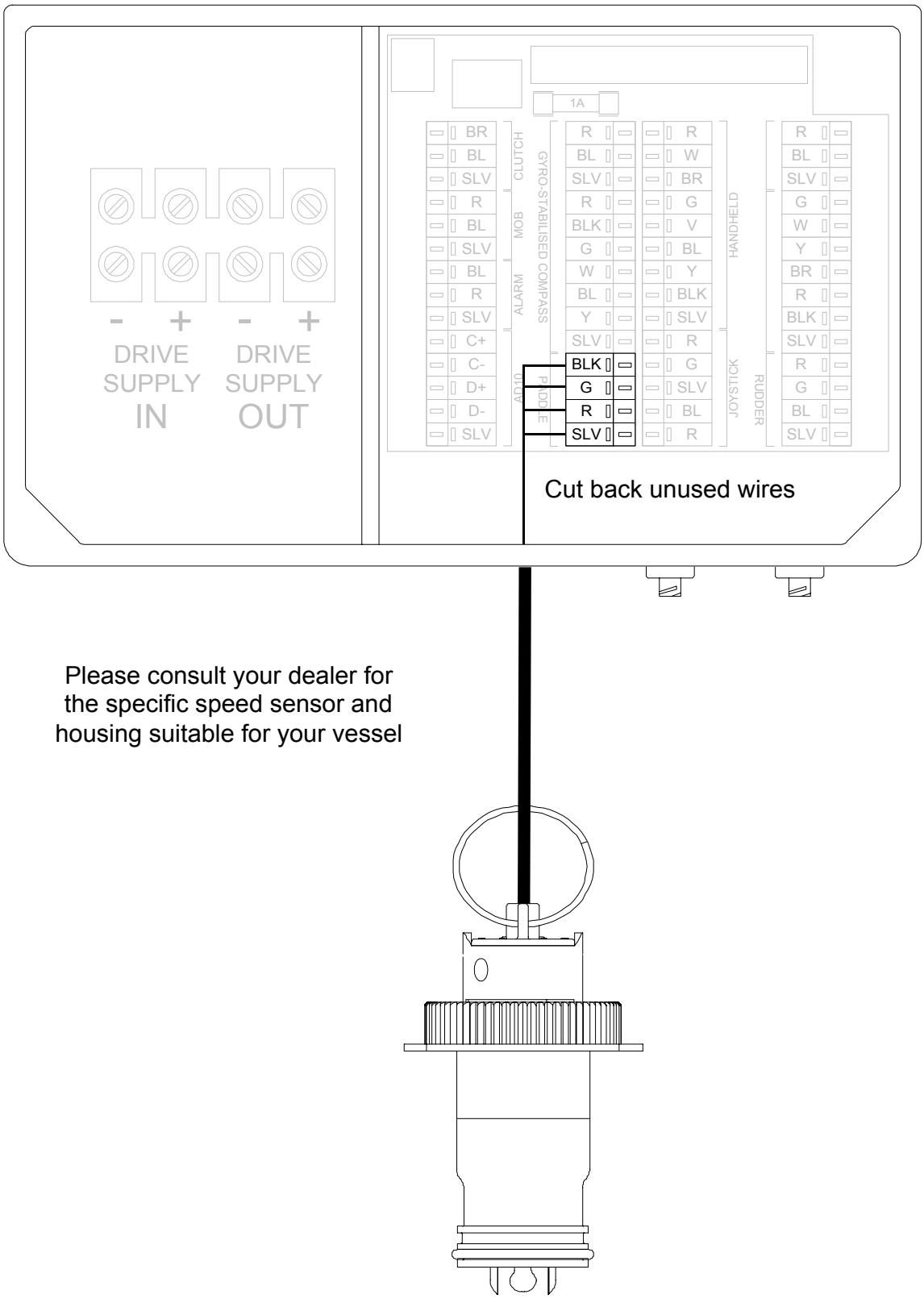
continuous drive unit connections

These are general wiring instructions only, showing the implementation of the ACP outputs to drive the continuous drive pump solenoid valves. The continuous drive pump motor will also require a heavy-duty supply, which is not provided. However, suitable units can be obtained from your dealer. Clutch output is used to control the motor supply.

Note: The ram solenoid must be designed to operate at the same voltage as the pump.



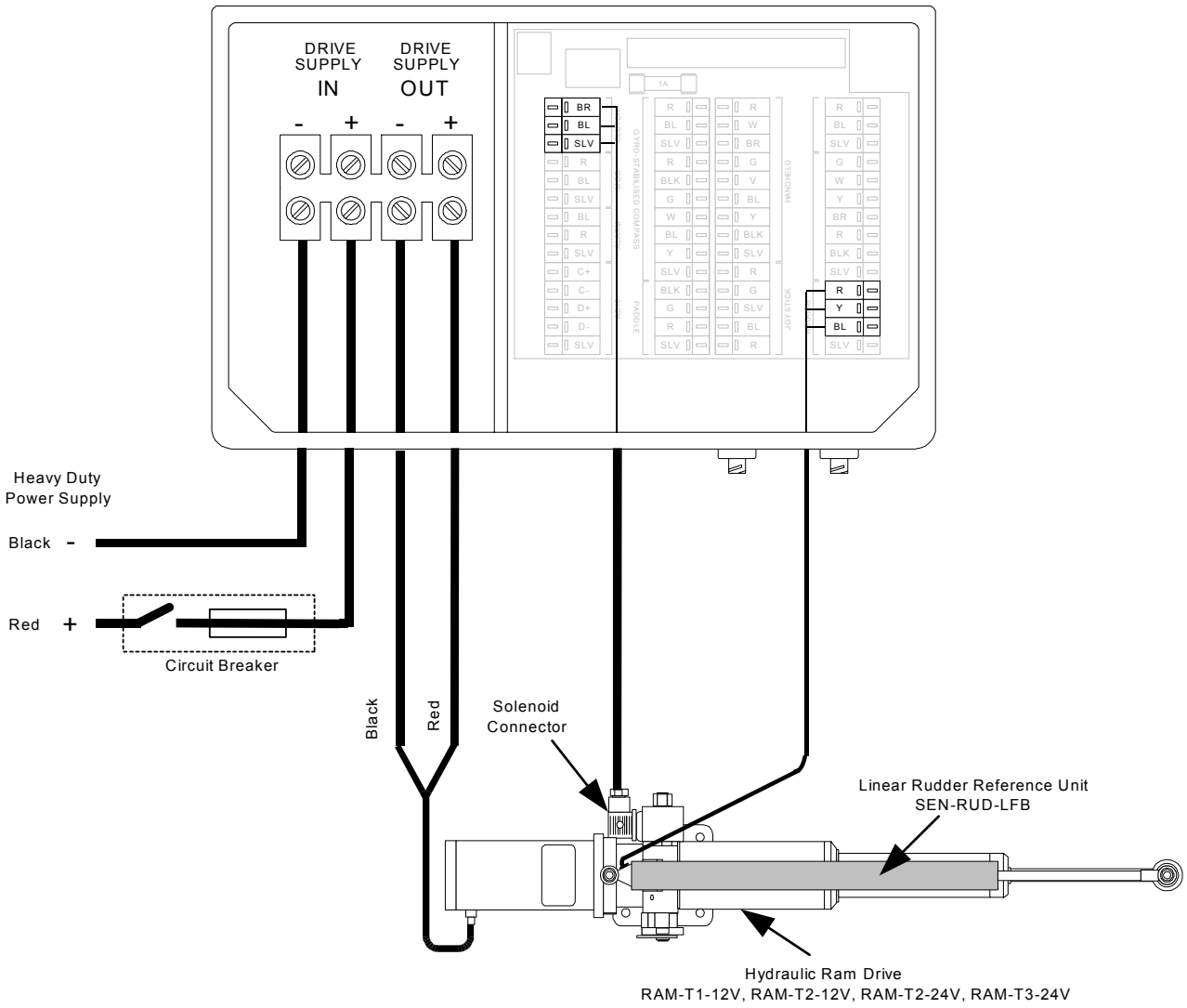
direct paddle input connection



Please consult your dealer for the specific speed sensor and housing suitable for your vessel

linear feedback connection

When the linear feedback unit is used, connect the linear feedback unit to the h1000 pilot terminals using the diagram and reference table below.



h1000 Processor Colours	Function	Linear Feedback Colours
Red	+5V Supply	Red
Blue	0V Supply	Black
Green	Signal (Wiper)	Yellow

non-B&G paddle connection

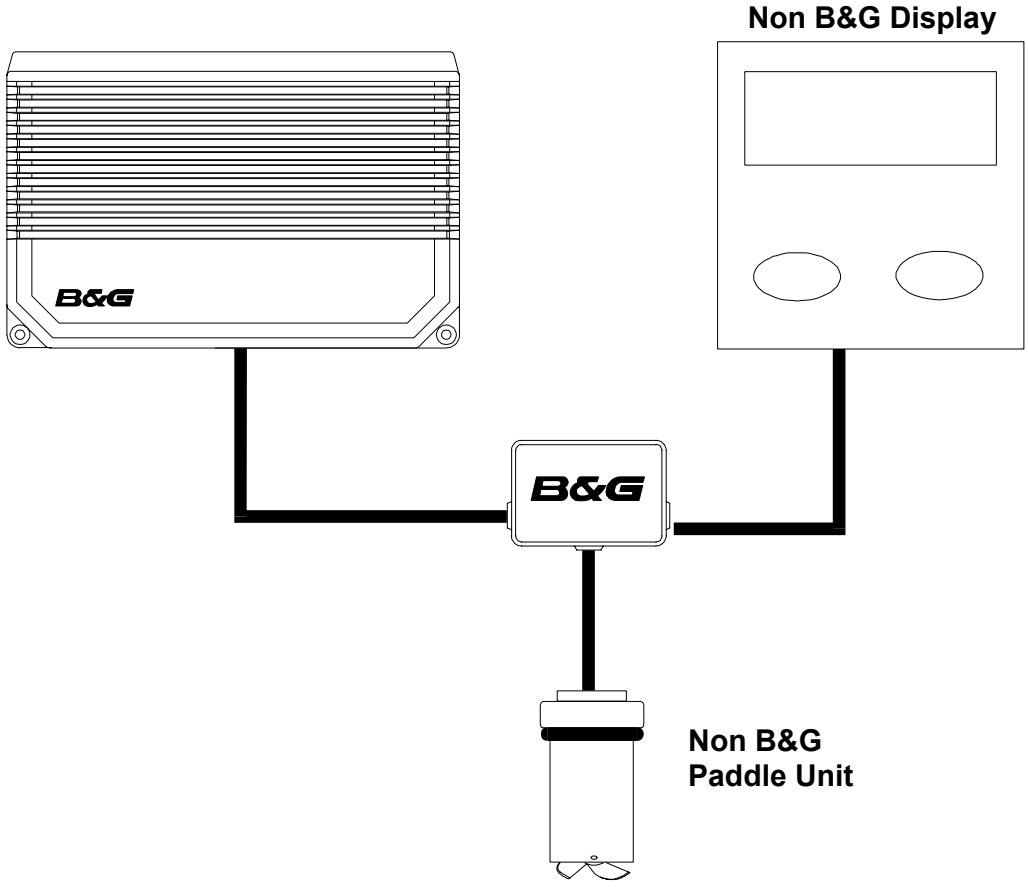
Any non-B&G speed sensor used with this system must have a speed signal output from a hall-effect device giving positive pulses of 12V maximum.

1. Locate the cable from the speed sensor to the instrument input.

2. Cut cable (if necessary) and insert a junction box (B&G part no. 288-00-001). Connect like colour to like colour.

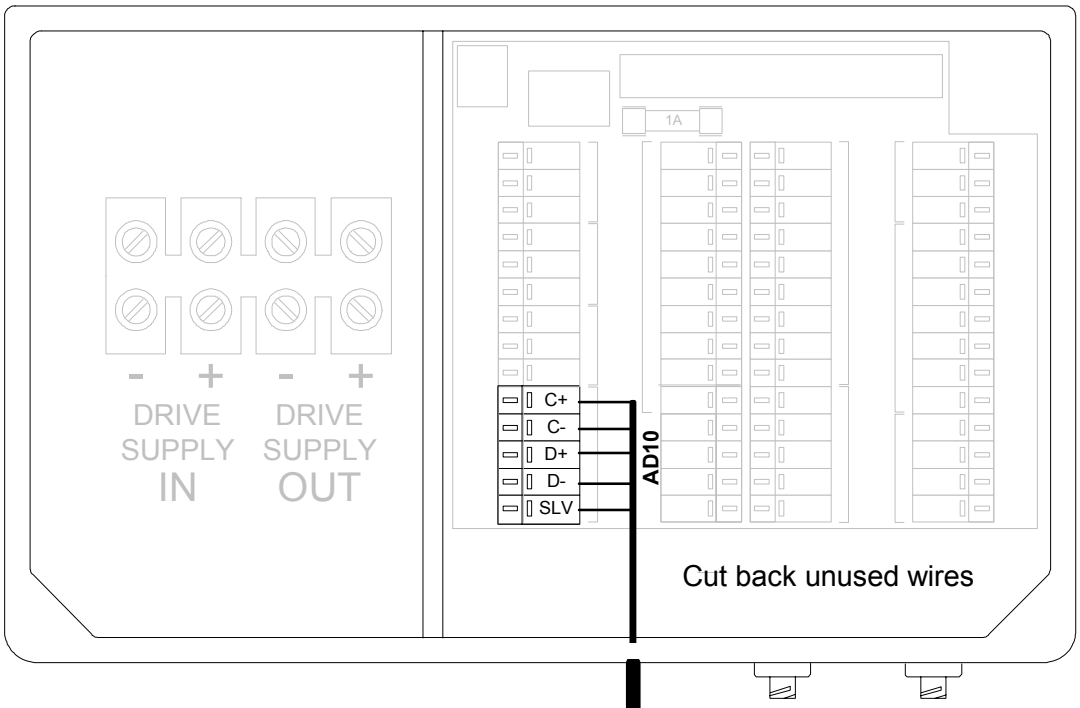
3. Use a length of 2-core screened cable (B&G part no. 135-0B-098 9m/30ft) to connect the speed signal and ground of the paddle sensor to the speed input of the ACP computer unit.

4. Calibrate the speed input in accordance with the instructions given in the Speed Calibration section of the h1000 System User manual.

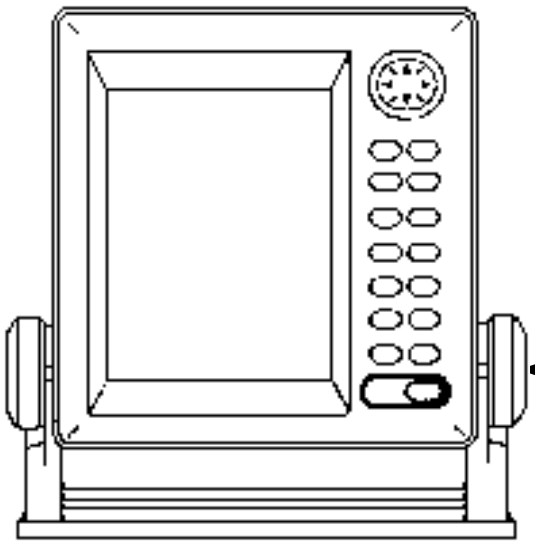


ACP Boat Speed Terminals	Function	Cable 135-0B-098
Green	Speed signal input	Red wire
Red	Not used	Not used
Black	Ground	Blue wire
Silver	Screen	Screen

furuno ad10 heading connection



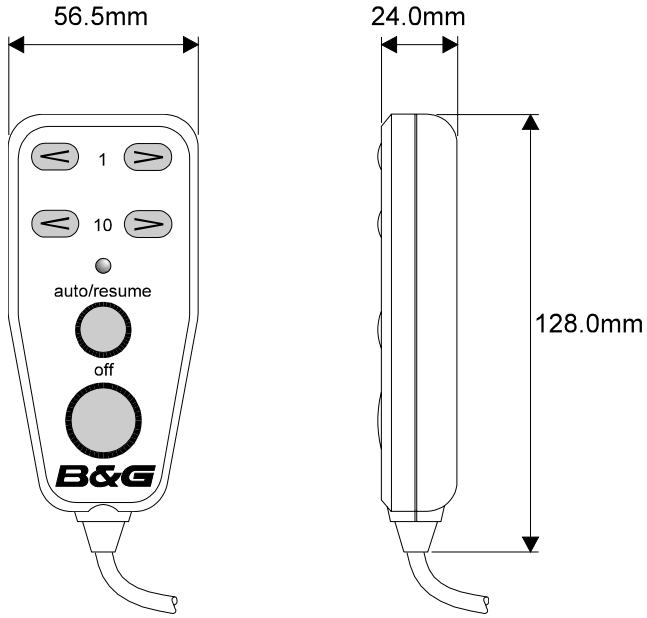
Furuno AD10 Output Cable



Furuno AD10 Compatible Display

INTENTIONALLY LEFT BLANK

hand-held controller



description

The hand-held remote controller is a weatherproof unit that has six function buttons and a status LED to indicate the operating mode of the autopilot. The unit provides palm-of-the-hand control of the pilot. The cable has a 10m (30ft) straight section, plus a coiled length that extends from 1m to 3m.

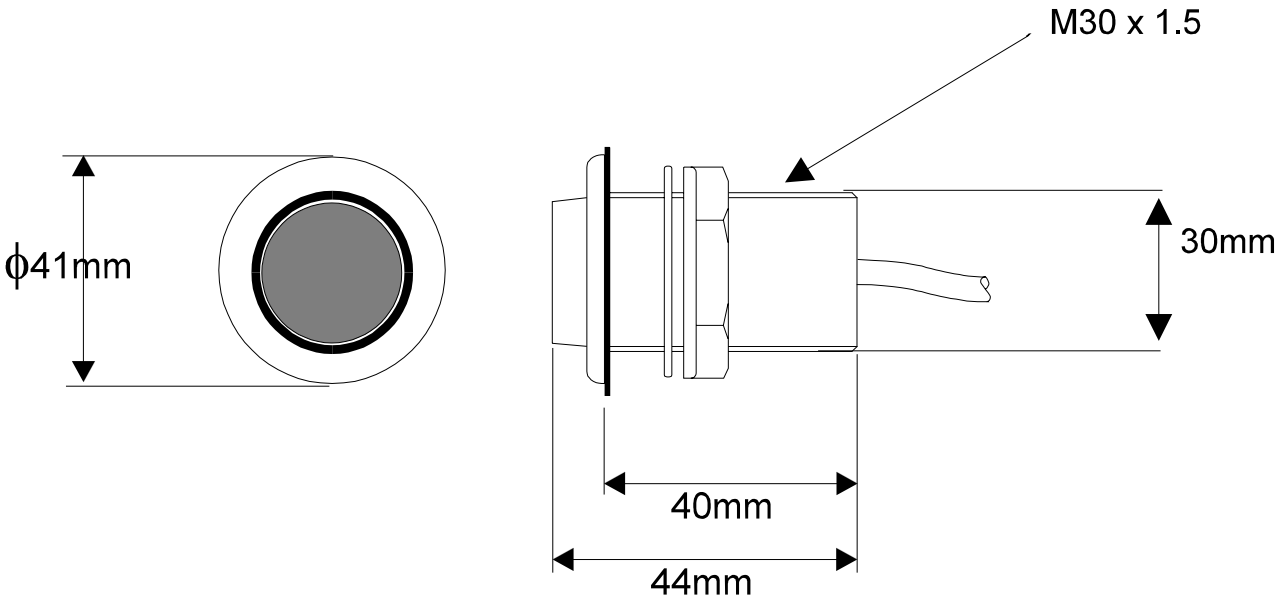
siting the hand-held unit

- At a convenient position within easy reach by the crew.
- Ensure at all times the hand-held remote controller's cable cannot become snagged on any moving parts; e.g. throttle controls.

mounting procedure

- Heavy-duty self-adhesive Velcro® strip is supplied with the unit.
- Clean and de-grease the site, stick the Velcro® firmly in place.

man overboard button (mob)



description

The man overboard (MOB) button is a large, red, weatherproof press-switch supplied with 15m (45ft) of two-core screened cable. Operation of this button will start the MOB sequence of operations, if fitted, an audible alarm will sound when the button is pressed.

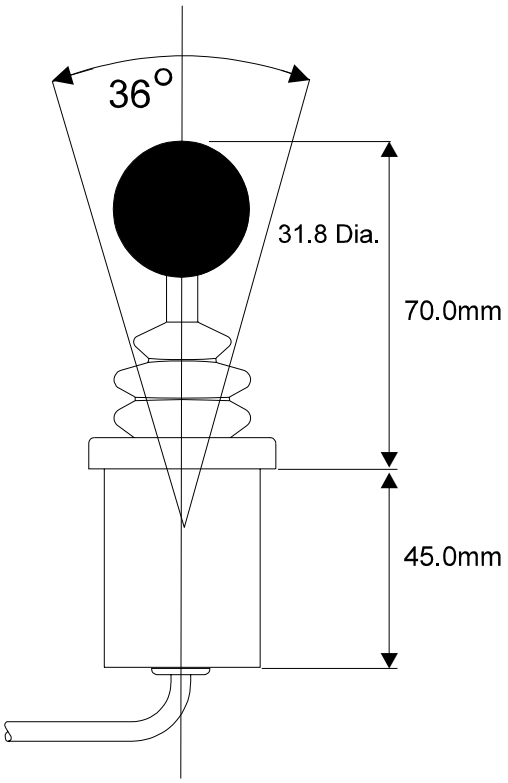
siting the man overboard alarm button

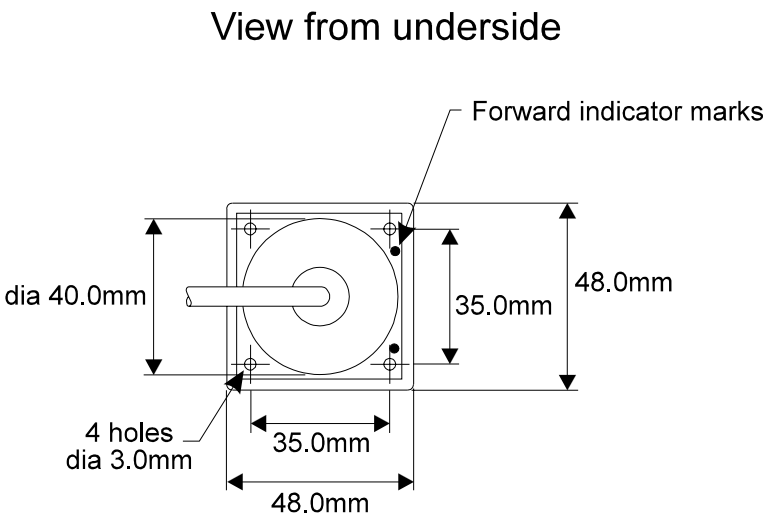
- Select a suitable bulkhead, easily accessible to all crew in an emergency.

mounting procedure

- With a 32mm (1¼") hole-cutter, cut a clearance hole for the button body.
- Remove the nut and washer, then carefully feed the cable through the hole ensuring that the sealing gasket is in place to prevent moisture ingress.
- From behind the bulkhead, feed the washer and nut over the cable and tighten the nut onto the switch body.

acp joystick





description

The joystick allows direct control of the rudder via the autopilot control electronics. The unit is deck-mountable, allowing it to be used both above and below decks. A 10m (30ft) 3-core screened cable is used to connect the unit directly into the h1000 ACP unit.

Joystick steering is engaged and disengaged with the separate red button, which should be mounted in the same manner as the MOB button, at a location close to the position selected for mounting the joystick. The lever can only be moved to port or to starboard.

siting the joystick unit

- At a convenient position within easy reach of the helmsman.

mounting procedure

- To ensure correct steering sense the unit is marked with two indents. The unit must be installed with these forward.
- The unit requires at least 65mm (2.5") clearance behind the selected mounting position.
- Use a 40mm (1 9/16") hole cutter for the joystick body.
- Ensure the gasket is fitted under the joystick body flange.
- Secure in place with the self-tapping screws supplied.
- Route the cable to the ACP unit. Connect as per instruction detailed in the relevant section of this manual.

h1000 pilot calibration

pilot installation checklist

Before the h1000 pilot can be used, it is necessary to set and calibrate various parameters. The checklist below should be used prior to the calibration of the autopilot. This will ensure that the entire system is correct before applying power.

drive unit and steering system

1. Drive unit securely fixed to a rigid part of the boat structure... ❒
2. Gauge of power cable is appropriate ❒

linear hydraulic rams

1. Boat end stops must limit the rudder movement, not the stroke of the hydraulic ram or RRU ❒
2. Split pin that holds the pivot pin in the mounting foot is secure ❒
3. Absence of oil leaks ❒
4. Correct diameter bolt in universal ball joint, correct size hole in tiller ❒
5. Ram free to move side to side & up and down ❒

size 3 ram installation check list

1. The base foot of the ram and pump have been firmly bolted into position ❒
2. The reservoir has been fixed to a bulkhead above the ram and pump ❒
3. The sealed reservoir transit cap has been replaced by the breather cap supplied ❒
4. The reservoir has been switched to the **ON** position ❒
6. Additional reservoir fitted (Size 3 only) ❒
7. Reservoir at highest point (Size 3 only) ❒

Tap "**ON**" position is in line with the pipe.

The piston rod can now be extended or retracted and the pump run.

hydraulic pumps

1. Absence of oil leaks ❒
2. Absence of air in the hydraulic steering ❒

rotary drives

1. No backlash or excessive slackness in chain ❒

h1000 pilot calibration

rudder reference unit installation

1. Base securely fixed to boat structure ❒
2. Arm securely fixed to boss ❒
3. Ball joint securely fixed to arm ❒
4. Linkage has not been over extended ❒
5. No slack or backlash in the linkage ❒
6. Linkage does not foul when rudder moved hardover to hardover ❒
7. Arm moves through at least 90^0 when rudder moved hardover to hardover (there must be at least 1V difference between the end stops) ❒
8. Ball-joint securely fixed to quadrant/tiller ❒

linear feedback unit installation

1. Ensure that the linear feedback unit is attached correctly to the linear actuator using the bracket kit supplied ❒
2. Ensure that the ram stroke does not exceed the stroke of the linear feedback unit ❒

compass installation

1. Clear of sources of magnetic interference, including power cables to other equipment. If in doubt, check 1m around with a small hand compass. Look on the other side of the bulkhead! ❒
2. Fitted as near to centre of motion of boat as other factors allow, aft of centre preferred because usually less motion than fore of centre ❒

electronics installation

1. Cables secure ❒
2. Cables undamaged ❒
3. No loose bits of wire ❒
4. Screens connected in accordance with wiring instructions and sleeved where appropriate ❒

speed calibration

Speed calibration sets the units of measurement, damping and speed calibration factor

units

Boat speed values can be shown in knots, kph or mph. To change the units, highlight Unit and press **ENTER**. Using the **UP/DOWN** keys, highlight the desired choice and press **ENTER** to memorise.

damping

Boat speed damping allows you to slow down the response of speed readings in rougher conditions by adjusting the damping value from 0 to 9. For minimum damping, set the value to 0, for maximum damping, set the value to 9.

adjustment

Speed adjustment calibration is necessary to compensate for hull shape and paddlewheel location on your boat. For accurate speed and log readings, it is essential that the paddlewheel is calibrated.

adjustment - auto

This procedure will automatically calibrate the boat speed and log readings ,and is the recommended method for most boats. This procedure requires the boat to make consecutive runs, under power at a constant speed, over a known distance.

Select two markers that are easily identifiable on the ground and on a chart, and where the effects of tidal flow is at a minimum. Measure and record the distance between the markers on the chart.

It is recommended that three runs are carried out, this accounts for tidal efforts, and improves accuracy. However, a time should selected when the current is at a minimum, i.e. slack water between tides.

1) From the **Speed Calibration Menu**, highlight Adjustment , choose auto from the drop-down box, and then press the **ENTER** key to confirm.

2) If necessary, adjust the **Run Length** to correspond with your measured distance and then highlight OK, and press **ENTER** to accept.

3) The display will now show **Run 1** and start will be highlighted. Maintaining the boat at your constant speed, press **ENTER** when the boat is in line with the start of your measured distance. The display will now change to show **Run 1** with end highlighted.

4) When the boat is in line with the second marker of your measured distance, press the **ENTER** key to temporarily halt the calibration. **Run 2** and start will now be shown on the screen.

5) Maintaining your constant boat speed, turn the boat through 180° in preparation for your second run along the measured distance. When the boat is in line with the second marker, press the **ENTER** key to resume the calibration procedure. The display will now show **RUN 2** and end will be highlighted.

6) When the boat is in line with the first marker, press the **ENTER** key. This will temporarily halt the calibration procedure.

7) Repeat the procedure detailed above for **Run 3** .

8) Upon completion of **Run 3,** highlight accept all and press **ENTER**. The system will now automatically calculate the new boat speed and update the readings accordingly.

speed calibration

adjustment – ref

Reference speed adjustment, allows for quick and easy calibration of your boat speed readings against a known calibrated source; for example, speed over the ground from a GPS or alongside another boat with a calibrated log.

1) From the **Speed Calibration Menu**, highlight Adjustment, select ref from the drop-down box and press **ENTER** to select. The display will now show the **Reference Speed** page.

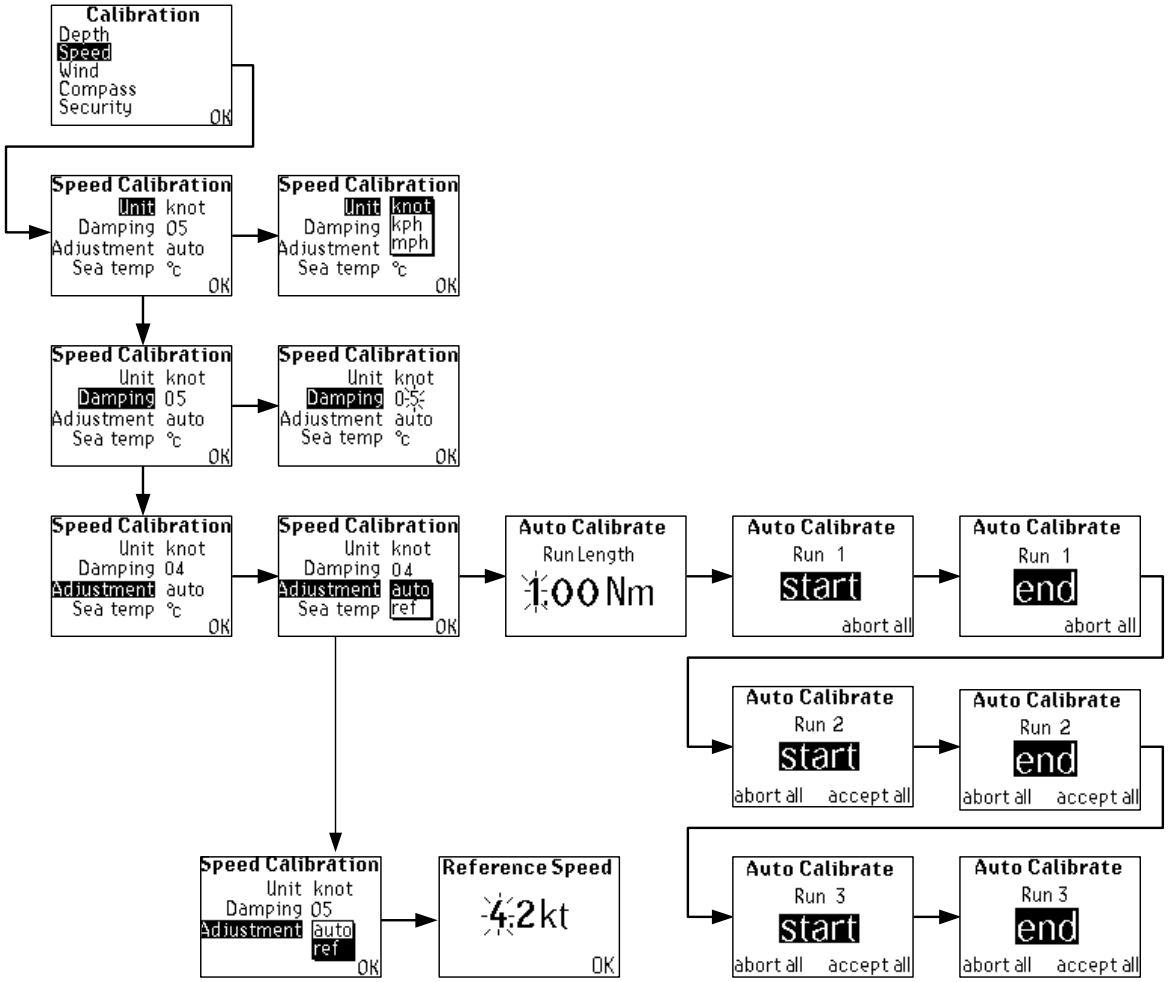
2) If speed over the ground data is available on the system from a GPS, the h1000 will automatically detect this and display this value on the screen with the message **from SOG**. To accept this value, simply highlight OK and press the **ENTER** key.

3) If speed over the ground is not available, simply highlight the speed value and, using the **UP/DOWN** and **ENTER** keys, adjust the value to the known reference boat speed.

4) Next, highlight OK and press **ENTER** to complete the operation.

sea temperature units

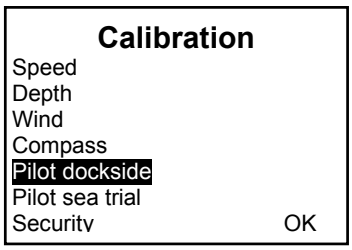
Sea temperature information can be shown in °**c** or °**f**. To change the units, highlight **Sea temp** and press **ENTER**. Using the **UP/DOWN** keys, highlight the desired choice, and press the **ENTER** key to memorise.



calibrating the pilot

Calibration

With the system ON, press ENTER and select calibration



calibration menu

The procedures for calibration can be divided into two sections. The first is carried out at the dockside (Dockside Calibration) and the second is carried out or checked during the course of a sea trial (Sea Trial Calibration).

pilot calibration parameters

The following is a list of the pilot calibration parameters that must be set for successful pilot operation.

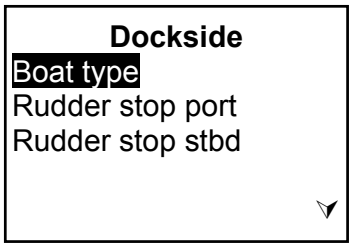
Boat type	Select boat type: sail, power planing, power displacement
Rudder stop port	Set port rudder stop position
Rudder stop stbd	Set starboard rudder stop position
Drive type	Select drive type connected to pilot
Hardover time	Measures the hardover port to hardover starboard time
Waterline length	Set the waterline length of the boat
Dip angle	Set the magnetic dip angle
Joystick control	Set the joystick steering mode: normal, proportional
Rudder amidships	Set the rudder amidships position
Boat lag	Set the boat lag value
Rudder gain	Set the rudder gain value

dockside calibration

The following parameters must be set prior to a pilot sea trial. The procedures to do this are described in this section of the manual:

- Boat type
- Rudder stop port
- Rudder stop stbd
- Drive type
- Hardover time
- Waterline length
- Joystick control

dockside calibration



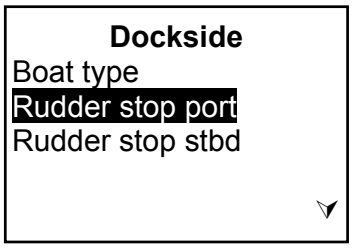
selecting the boat type

There are three selections available:

- **sail:** for all sail boats.
- **power disp.: f**or power boats with displacement hulls.
- **power planing:** for power boats with planing hulls.

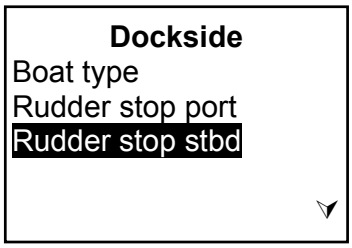
setting the rudder end stops

Before the h1000 pilot can be used, it must know the position of the rudder end stops.



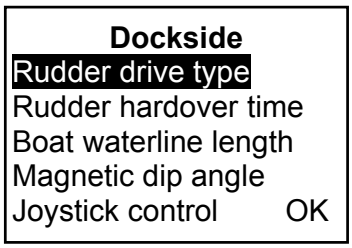
setting the port rudder stop

Move the rudder to the hardover port position. Press the **ENTER** key and select **set** to store the port position.



setting the starboard rudder stop

Move the rudder to the hardover starboard position. Press the **ENTER** key and select **set** to store the starboard position.



selecting the rudder drive type

Depending upon the type of rudder drive unit fitted, the pilot controls the rudder drive motor in different ways. This optimises the autopilot steering response.

There are four selections available:

1. **normal** Ram drives, hydraulic pumps, rotary drives, all sizes and voltages.
2. **pedestal** Pedestal drive motors fitted by some steering gear manufacturers.
3. **outdrive** Outdrive drive units and continuous drive units.
4. **special** Proportional drive systems.

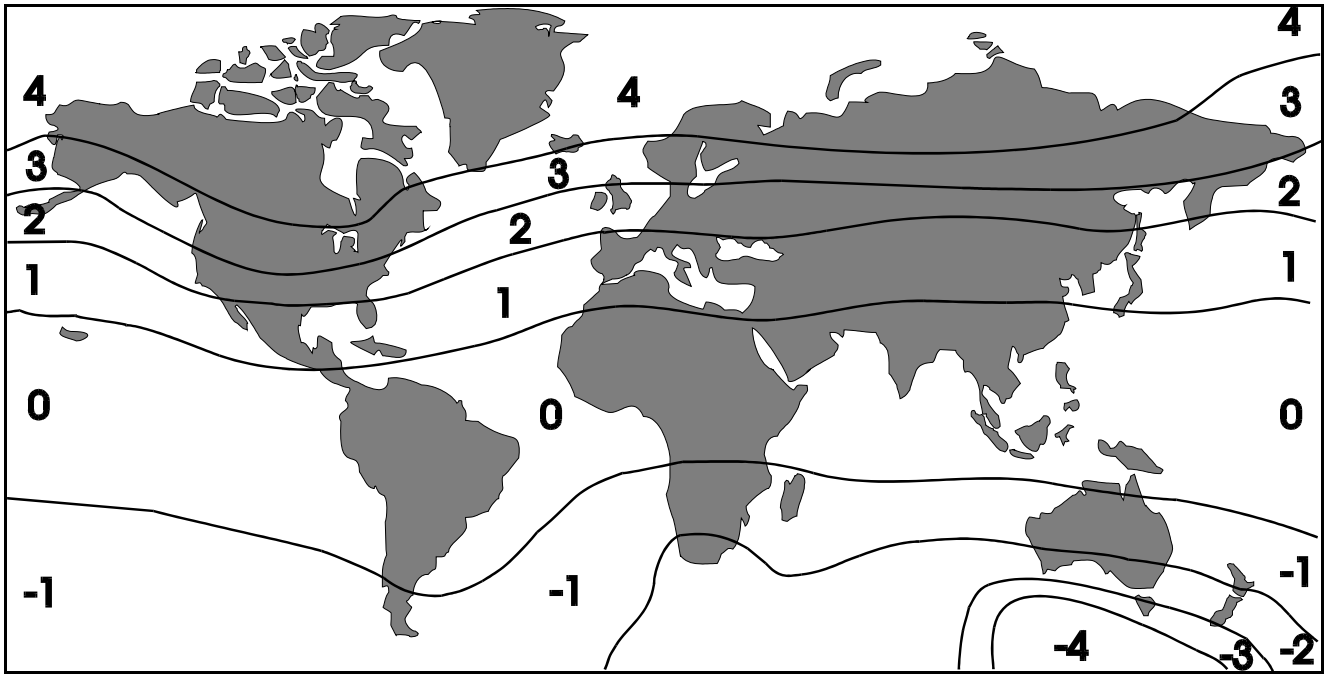
Dockside Rudder drive type Rudder hardover time Boat waterline length Magnetic dip angle Joystick control OK	**hardover time** To finish the rudder end stop calibration procedure the autopilot must calculate the rudder hardover port to hardover starboard time. The following points must observed before carrying out the procedure: • If the boat is equipped with hydraulic power assisted steering the engines must be running when setting the rudder end stops and measuring the hardover time. • Move rudder to midships position. • Highlight the 'START' command. • Keep clear of the wheel. • Press the ENTER key to start test. The rudder hardover to hardover time can only be calculated with the boat stationary.
	If during the hardover timing, the rudder does not move, check: • The boat speed is less than 3 knots. • The rudder reference unit must move through an angle of at least 90^0 when the wheel is turned from hardover to hardover. • The output variation from the rudder reference unit is greater than 1V from hardover port to hardover starboard. • Refer to the installation section for the rudder reference unit and check the installation. • The separate power supply to the ACP control unit is switched on.
Dockside Rudder drive type Rudder hardover time Boat waterline length Magnetic dip angle Joystick control OK	**waterline length** Boat waterline length must be entered into the autopilot for it to steer accurately. This value can be entered in metres or feet.

dockside calibration

magnetic dip angle (for boats faster than 20 knots only)

All magnetic compasses are effected by 'Northerly turning errors' in the Northern Hemisphere or 'Southerly turning errors' in the Southern Hemisphere, which increase with boat speed and magnetic dip angle in higher latitudes. These can cause heading instability at boat speeds greater than 20 knots when steering with an autopilot. By entering the dip value indicated on the compensation chart, the autopilot will be able to correct for these errors and improve the heading stability. Use the minimum value necessary to stabilise the heading.

magnetic dip angle compensation chart



Dockside	
Rudder drive type	
Rudder hardover time	
Boat waterline length	
Magnetic dip angle	
Joystick control	OK

joystick control

The joystick is an optional device that allows direct control of the rudder. There are two joystick operating modes available to the helmsman:

Normal: the rudder moves in the direction of the joystick. When the joystick returns to the central position the rudder movement stops. The greater the movement of the joystick, the faster the response of the rudder.

Proportional: the position of the rudder follows the position of the joystick. When the joystick returns to the central position the rudder returns to its initial position.

Note: Until all parameters have been set or checked the autopilot should not be used to steer the boat.

seatrial calibration

The following parameters should be set and checked during the initial sea trial.

- Compass Swing
- Rudder Amidships
- Boat Lag
- Rudder Gain

The sea trial calibration should be carried out in open water on a calm day. The procedures for the remainder of the calibration involve continual course and speed changes. It is very important to maintain a constant lookout at all times. Use proper seamanship when clearing turns to ensure the calibration is carried out safely.

The autopilot will be initially operating from the factory default values for boat lag and rudder gain. During the sea trial the pilot learning algorithm will automatically set and adjust the value for rudder gain. The values for boat lag and rudder gain will be checked and adjusted to finely tune the autopilot steering performance when necessary. The default values are automatically set depending upon the type of vessel selected under boat type.

compass calibration

The **Compass Calibration Menu** sets the heading offset, damping, and swing parameters for the h1000 fluxgate compass.

compass offset

The compass offset electronically compensates for fixed errors (misalignment) between the fluxgate sensor and the direction of the boat. These errors will occur since the compass can be mounted in any orientation within the boat.

To accurately enter a compass offset, the boat's actual heading must be known, for example: reference the h1000 fluxgate against a calibrated bowl compass, or follow a known transit referenced from a chart.

To enter the compass offset value, highlight Compass from the **Compass Calibration Menu** and press **ENTER**. Adjust the value using the **UP/DOWN** and **ENTER** keys. The value entered should be between +180° and -180°.

Example:

- Boat's actual heading is 076°
- h1000 display shows 092°
- The compass offset entered should be -016°

To facilitate this procedure, **live heading** is shown on the screen so that the effects of the offset can immediately be seen.

compass damping

Compass damping allows you to slow down the response of compass readings in rougher weather by adjusting the damping value from 0 to 9. For minimum damping, set the value to 0. Increase the damping value if the readings are too unstable in rough weather.

compass swing

The swing procedure allows the compass to learn the effects of any magnetic deviation errors that are unique to your boat. The swing should be performed out in open water, on a calm day, with minimal wind and waves, and away from traffic, which may require the procedure to be aborted.

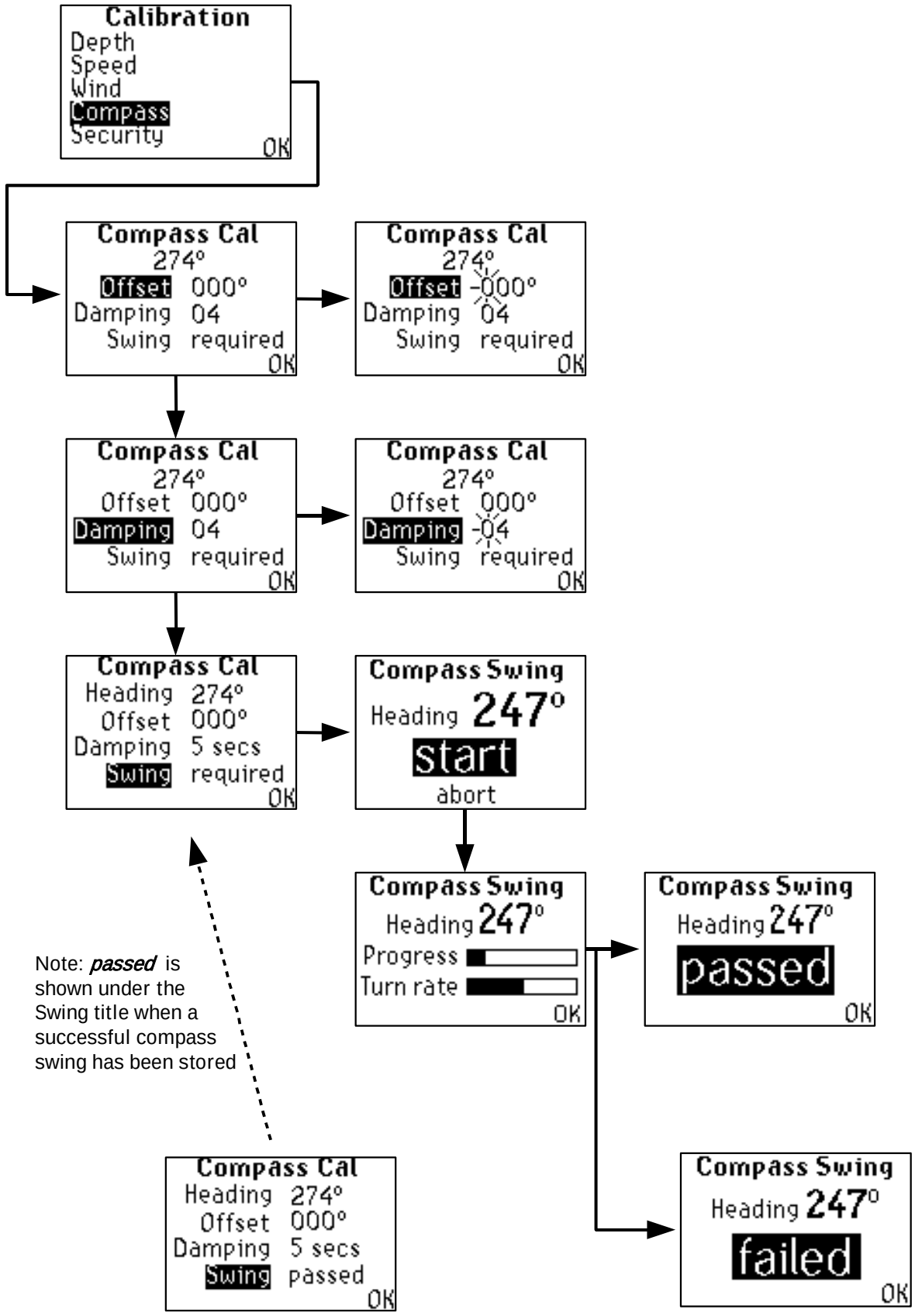
The swing procedure requires the boat to be turned through a complete 360° turn, at a speed of less than 5 knots, at about 2° per second. The entire process should take about three minutes to complete.

To swing the compass, highlight Swing and press **ENTER**. The **Compass Swing** page will now be displayed with start highlighted. With the boat settled on its turn, press the **ENTER** key to start the swing.

The display will now show two bargraphs. The first is the **Progress** bar, which will fill completely after the boat has been turned through 360°. The second is the **Turn rate** bar, which, for optimum results, should not be allowed to fill completely.

After completion of the swing, the message **passed** or **failed** will be shown. At any stage during the swing, the procedure can be aborted by selecting abort and pressing the **ENTER** key.

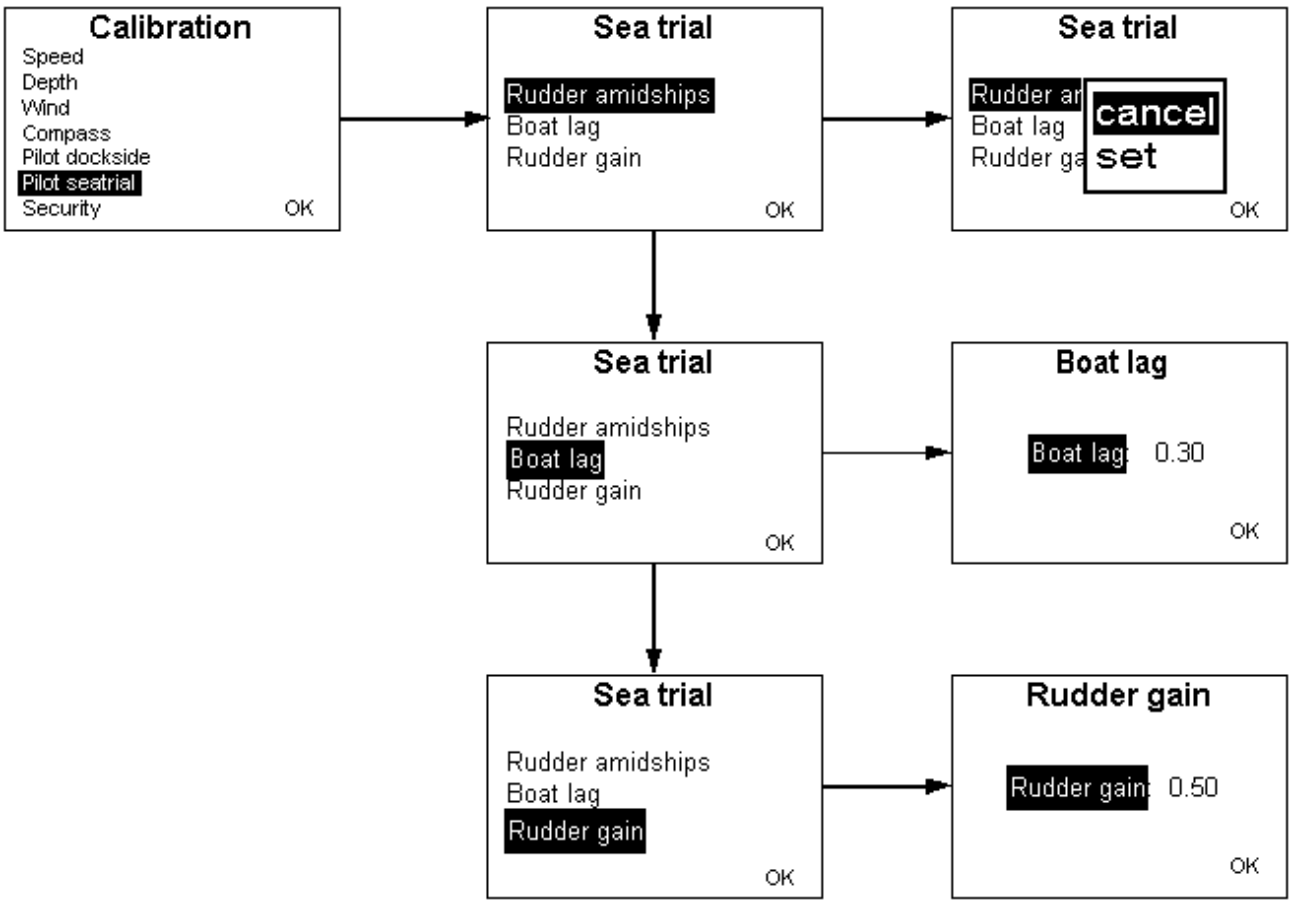
compass calibration



seatrial calibration

Notes:

- On the initial sea trial ***DO NOT EXCEED 15 KNOTS***
- Always maintain a proper lookout
- If in doubt, disengage the autopilot with the red **OFF** key on any pilot display or hand-held controller, and return to manual steering



seatrial calibration

engaging the h1000 pilot

1. Steer the boat onto a suitable heading and allow time for the boat to settle on this course.
2. Select **Compass Mode** by repeatedly pressing the **MODE** key.
3. Press the **ON** key on any h1000 pilot display or hand-held controller.
4. The autopilot will now be steering the boat on the selected heading.
5. Alter course in multiple increments using the 10° and rotary knob buttons on any h1000 pilot display or hand-held controller.

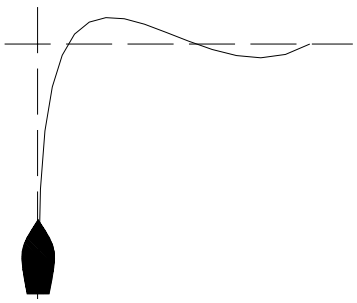
Press the red **OFF** key to disengage the autopilot and return to manual steering.

setting the rudder amidships position

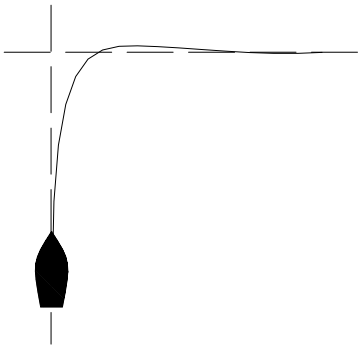
Due to hull design and steering characteristics, the best rudder amidships position can only be set when underway at normal cruising speed. Adjust the amidships position as follows:

1. Steer the boat into the wind and maintain a steady course.
2. Boats with twin engines must have the engine revs balanced.
3. Boats with trim tabs must have them in the normal cruising position.
4. Select Rudder midships from the Sea Trial menu and choose **set** from the drop down menu.

Boat Lag Incorrect



Boat Lag Correct



boat lag

Boat lag is the time taken for the boat to respond to changes in helm. For example, heavy displacement hulls require a larger value for boat lag.

1. Engage the autopilot as previously explained in Initial Pilot Sea Trial.
2. At a reasonably slow cruising speed (do not exceed 15 knots) change course by 90 in each direction.
3. Observe the autopilot steering performance. The boat should turn onto the new heading with minimal overshoot (a slight overshoot is acceptable).
4. If the overshoot is consistently more than 5 for course changes in both directions increase the boat lag value in steps of 0.1 until the overshoot is corrected.
5. It is easier to observe overshoot than undershoot, hence if no overshoot is observed decrease the boat lag in steps of 0.1 until a small overshoot is seen.
6. Use the smallest value of boat lag to stop overshoot.

seatrial calibration

	setting the boat lag value The autopilot must be disengaged to adjust the boat lag value.

boat lag value table

Boat Type	Default Value	Typical Value
Sail Boats	0.30	0.3 to 1.0
Power Boats	0.50	0.3 to 1.0

automatic rudder gain

When the h1000 pilot is part of an integrated h1000 system, boat speed data is supplied via the Speed/Depth Interface unit. This allows the autopilot to automatically 'learn' the correct value for rudder gain by monitoring boat speed and rate of turn. The rate of turn will be approximately 7.5° per second.

If there is no direct speed input or the speed is being set by the manual speed band selections, then the rudder gain value must be entered manually. Refer to **Manual Rudder Gain**.

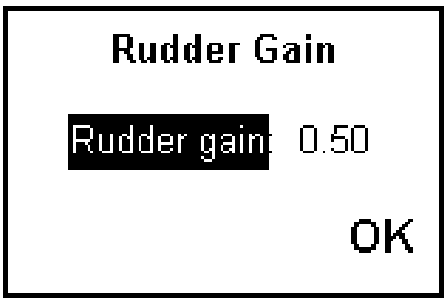
checking the automatic rudder gain learning

1. Steer the boat onto a suitable heading and allow time for the boat to settle on this course.
2. Select **Compass Mode** by repeatedly pressing the **MODE** key.
3. Press the **ON** key on any h1000 pilot display or hand-held controller.
4. The autopilot will now steer the boat on the selected heading.
5. **At a speed not exceeding 15 knots**, make at least six large course changes of at least 120°, by multiple presses of the 10° course change buttons on any h1000 pilot display or hand-held controller. This enables the autopilot to learn the rudder gain value.
6. When the autopilot has learnt the rudder gain value, the rate of turn will be approximately 7.5° per second. (To estimate the rate of turn the display is updated every 1 second, therefore the heading display should jump in 7° to 8° steps.)
7. Press the red **OFF** key to disengage the autopilot and return to manual steering.

seatrial calibration

manual rudder gain

1. Steer the boat onto a suitable heading and allow time for the boat to settle on this course.
2. Select **Compass Mode** by repeatedly pressing the **MODE** key.
3. Press the **ON** key on any h1000 pilot display or hand-held controller.
4. The autopilot will now steer the boat on the selected heading.
5. **At a speed not exceeding 15 knots**, make course changes of at least 120°, by multiple presses of the 10° course change buttons on any h1000 pilot display or hand-held controller.
6. Observe and estimate the rate of turn. It should be approximately 7° to 8° per second. (To estimate the rate of turn the display is updated every 1 second, therefore the heading display should jump in 7° to 8° steps).
7. Observe the performance of the pilot when changing course.
8. If the rudder gain value is too low, the autopilot will understeer, causing sluggish steering. If the rudder gain value is too high, the autopilot will oversteer, causing erratic steering and excessive rudder movements. In high-speed boats, this could cause a jerky response and dangerous rates of turn.
9. Adjust the rudder gain value for best steering performance. Use the minimum value necessary to maintain a good response to course changes and course keeping without excessive rudder movement.



setting the rudder gain manually

The autopilot must be disengaged and **Sea Trial calibration** mode selected to adjust the rudder gain value.

rudder gain value table

Boat Type	Default Value	Typical Values
Sail Boats	2.00	1.50 to 2.20
Power Boats	0.80	0.70 to 1.00

Note: the default value is selected by setting boat type and rudder drive type during calibration.

troubleshooting

trouble shooting introduction

The pilot control unit is continually monitoring the h1000 pilot and h1000 system for correct operation. If an error is detected the pilot display will show an overlaid error message, and the system alarm buzzer will sound if connected. To silence the alarm press any of the keys on the pilot display or any h1000 display.

uncalibrated

fault description: Rudder not calibrated or memory has been corrupted.
check list:

1. Has rudder ever been successfully calibrated?
   - Yes, go to 4.
   - No, go to 2.
2. Set rudder port and starboard positions. Move helm, does rudder indicator work?
   - Yes, go to 4.
   - No, go to 3.
3. Rudder indicator will not work until port and starboard positions have been entered. The difference in the signal from the rudder reference unit at the port end stop and the starboard end stop must be at least 1.0V. Check rudder reference installation and then repeat 2.
4. If rudder has previously been successfully calibrated then fault is due to memory corruption. This may be due to memory backup battery failure, or severe interference; e.g. lightning.
5. Recalibrate pilot and contact the nearest B&G dealer for advice.

no rudder position

fault description: Signal from the rudder reference unit is outside the limits set during calibration.
check list:

1. Check installation of rudder reference unit for slack or loose fittings.
2. Check wiring and the signal from the rudder reference with a volt meter at the pilot computer terminals. The voltage supply to the rudder reference should be 4.5 to 5.0V (between red-blue). With someone moving the helm, the signal measured between (blue-green) should change smoothly. If the signal is incorrect, suspect a faulty rudder reference unit. Note, the difference between the signal voltages measured at the two end stops must be at least 1.0V.(e.g. blue –green voltage minus red -green voltage must be greater than 1.0V).
3. Set pilot display to show digital rudder angle in degrees. Move helm to port and starboard end stops, check that the indicated rudder angle is 40° (±2°). If not, check the rudder reference installation to determine and rectify the reason for the end stop position changing and then re-enter the end stop calibration values.
4. Move helm slowly from end stop to end stop. Check that indicated rudder angle counts from 40° one side to 40° the other side without "missing" a count.
5. If the fault is always at the same rudder angle, suspect a faulty rudder reference unit.
6. If the fault is at different rudder angles suspect a fault in the wiring, the connections to the pilot computer, or the pilot computer electronics.

troubleshooting

no drive detected

fault description: The pilot attempted to move the rudder, but did not sense any change in rudder position, or, when the pilot attempted to move the rudder, it moved in the wrong direction.

check list:

1. Is the heavy duty power supply circuit breaker for the autopilot drive switched on?
2. Check installation, look for any slack or loose fixings in the drive system or the rudder reference as the helm is moved.
3. Move the helm, does the rudder indicator work, if not, check installation of rudder reference unit as detailed above.
   - Disconnect clutch from pilot electronics and test operation when connected directly to power supply.
   - Check correct power is applied: 2A maximum
   - Check that the dip switches in the ACP computer unit are set correctly for the rudder drive unit.
   - Check correct power is applied:

RAM-T1-12V	12V, 15A
RAM-T1-12V	12V, 15A
RAM-T2-12V	12V, 25A
RAM-T2-24V	24V, 25A
RAM-T3-24V	24V, 25A
4. If the fault only occurs intermittently or under heavy loads, use power steer mode to move rudder while restricting movement by holding wheel. Fault only occurring under these conditions could be due to:
   - Excessive motor current.
   - Too much slack or backlash in drive or fixing to tiller, possibly due to air in hydraulic system.

no boat speed

fault description: The boat is stationary or moving very slowly (less than 1.5 knots) or the speed sensor is not working.

check list:

1. If boat speed for pilot comes from instrument system, check speed shown h1000 display or pilot display.
2. If boat speed connected directly to pilot, check connections.
3. Check boat speed sensor for correct operation.

no heading data

fault description: Compass data from the h1000 compass NMEA (via Fastnet^2) or gyro input into the ACP has stopped or become unreliable.

check list:

1. Check heading display on pilot display unit.
2. Check connections from compass sensor to the h1000 Fastnet^2.
3. Check gyro sensor and wiring if compass data is from an external device.
4. Check NMEA heading data and wiring if compass data is from an external device.

troubleshooting

no nmea information

fault description: The pilot has stopped receiving waypoint data from the position fixer.

check list:

1. Check cross track error display on pilot display or h1000 display.
2. Check connections to pilot system.
3. Check operation of position fixer. Has NMEA output been selected and enabled? Has autopilot output been enabled? Does the position fixer have a fix? Refer to position fixer manual.

nmea data unstable

fault description: The value of cross track error data being received has suddenly changed by more than 0.3Nm.

check list:

1. Check cross track error on display for stability.
2. Check operation of position fixer, especially signal and noise levels. Refer to position fixer manual.

poor wind data

fault description: There is no valid wind data being received via the h1000 Fastnet^2 databus, or the wind speed is less than 1 knot.

check list:

1. Check wind functions on h1000 digital display or pilot display.
2. Check masthead unit connections to instrument system.
3. Check NMEA connections to NMEA interface if wind source comes from another instrument.

current trip limit

fault description: The voltage or current limit circuit for the drive motor or the clutch has tripped.

- 12/24V drive motor: 25A
- Clutch: 2A

check list:

1. Check installation and wiring for short circuits.
2. Check current to clutch; maximum available 2A.
3. Check maximum current to drive motor is less than 25A.

no pilot detected

fault description: No regular messages being received by pilot display from pilot computer unit; i.e. either the display is not receiving or the pilot computer is not transmitting.

check list:

1. If other displays show pilot data, check installation of pilot display or suspect faulty pilot display.
2. If no pilot data on any display, check installation of pilot computer or suspect faulty pilot computer.
3. Check installation of h1000 Fastnet^2 cable.

troubleshooting

pilot not steering a straight course

fault description:
The pilot seems unable to steer straight, it continually overcorrects course errors; the wake has an "S" like appearance as the boat first steers several degrees off-course to port followed by several degrees off course to starboard.

check list:

1. Drive unit: check for any slack or backlash in the drive system.
2. Rudder reference: check for any slack or backlash in the assembly and associated linkages.
3. Boat speed: check that the boat speed input is operating correctly.
4. Settings: read the calibration section carefully and check that the settings are appropriate for the type of boat.
5. Rudder gain: make large course changes using the pilot. If the gain value is correct the rate of turn should be between 6° and 8° per second. Adjust if necessary.
6. Boat lag: a boat lag value, which is too small for the boat, can cause instability. Try increasing the value.
7. Check location of compass sensor in vessel. Ensure that the sensor is not affected by the proximity of cables carrying heavy currents, loudspeaker magnets or ferrous metals.